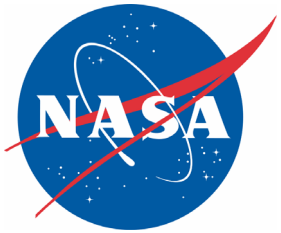
Rapid Response with the USDA Forest Service

Use of NASA EOS Data to Improve Federal Response to Wildfire

SENH Review, 4 May 2005



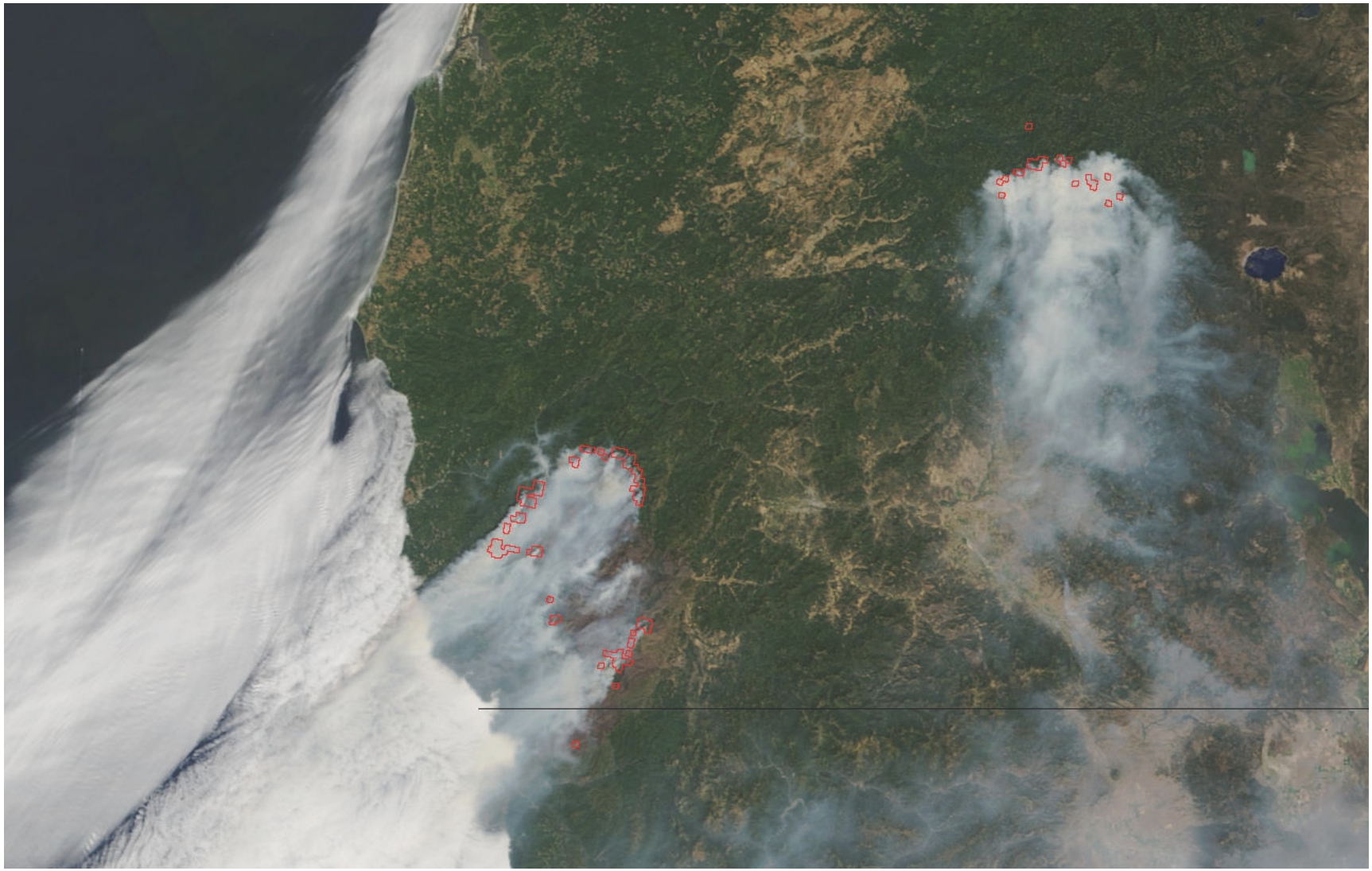
Robert Sohlberg
sohlberg@umd.edu
Chris Justice and John Townshend
University of Maryland

with collaborators at:
USFS Remote Sensing Applications Center
National Interagency Fire Center
UAF / Alaska Fire Service
NASA Goddard Space Flight Center
NASA Ames Research Center
NASA Jet Propulsion Laboratory
NASA Dryden Flight Research Center
NOAA-NESDIS / SSEC
EROS Data Center

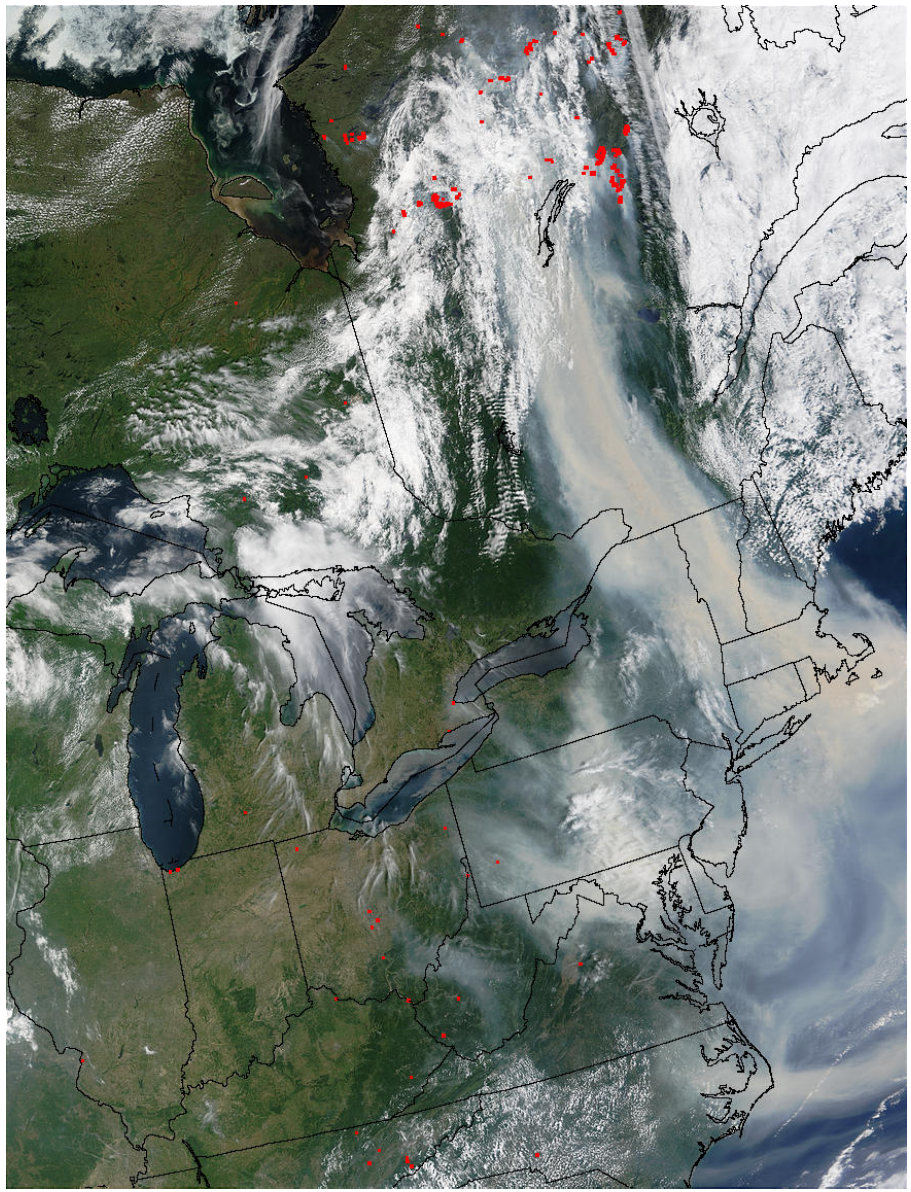
Fire Detection

Biscuit and Tiller Fires in California and Oregon

August 14th, 2002 at 19 :15 UTC



Wildfires in Quebec and smoke over United States East Coast
July 7th, 2002 at 16:35 UTC



Fire Detection Algorithm

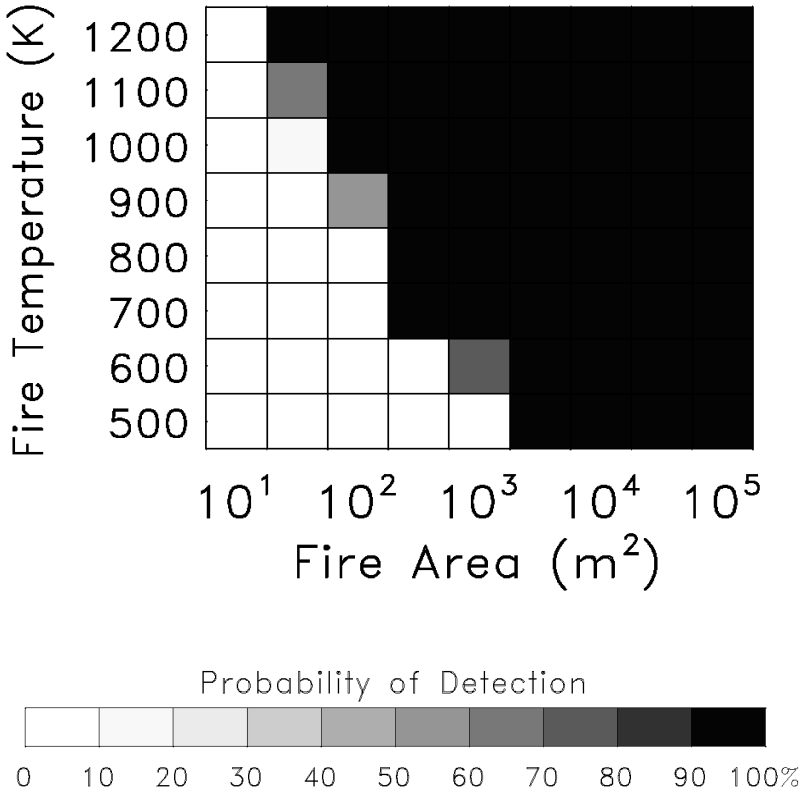
- Exploits strong emission of mid-infrared radiation from fires
- Contextual approach
  - Uses neighboring pixels to statistically characterize non-fire pixels
  - Fire pixels must stand out significantly from background
  - Absolute threshold (360 K) used to identify extremely obvious fires

Fire Detection Algorithm (cont.)

- Specialized tests for specific types of false alarms
  - Sun glint
  - Inaccurate land/sea mask
  - Desert/non-desert boundaries
- Assigns single class to each MODIS pixel
  - *missing data*, *water*, *cloud*, *non-fire*, *fire*, or *unknown*

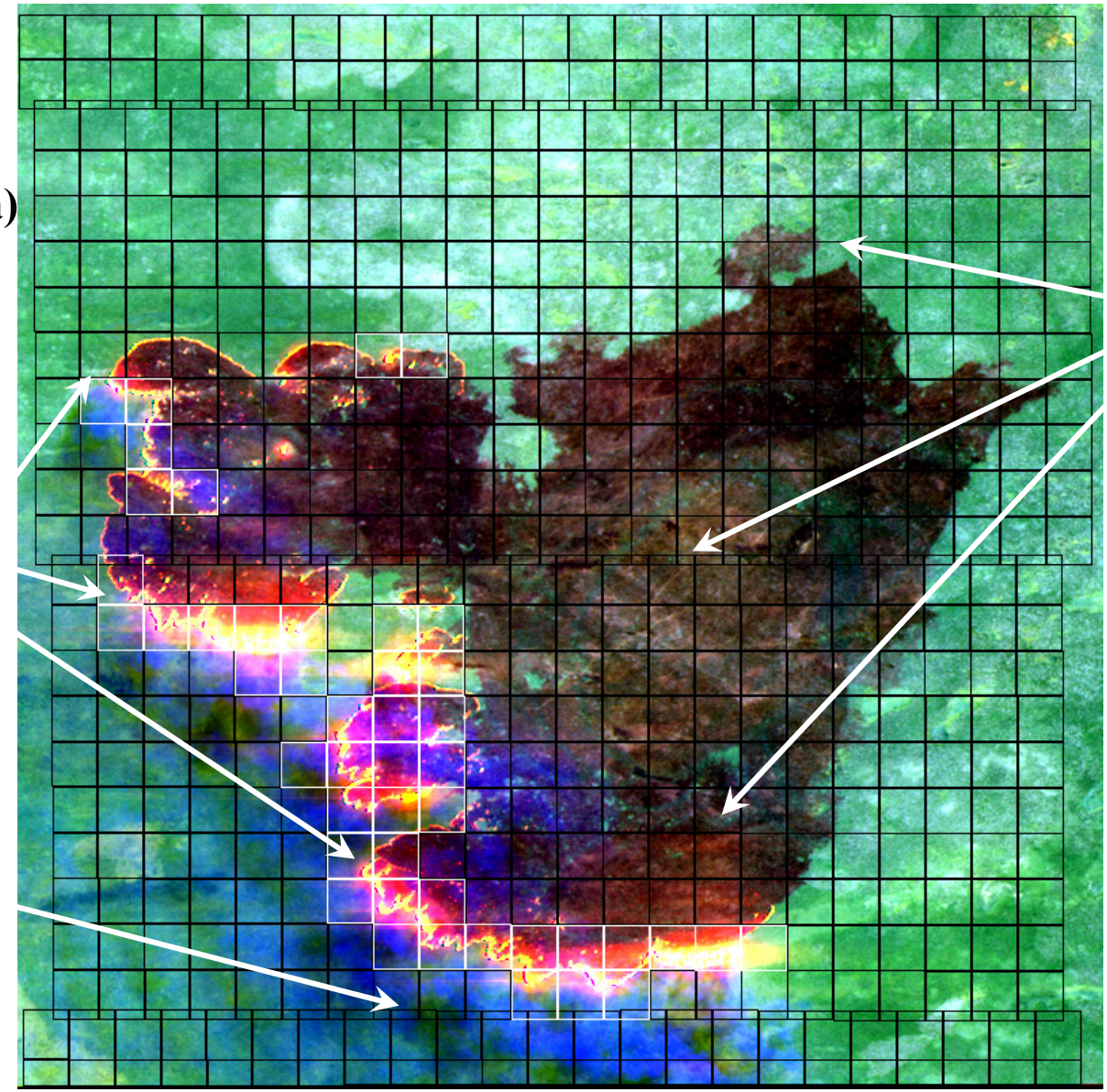
Algorithm/Instrument Performance

- MODIS
- Temperate deciduous rainforest
- Night
- 0° scan angle
- Summer
- No background fires



Active Fire Validation
Collocating ASTER and MODIS data

Aug 17 2001
09:08 UTC
18.8S 19.9 E
(NE Namibia)



White squares:
MODIS fire pixels

Burn scar

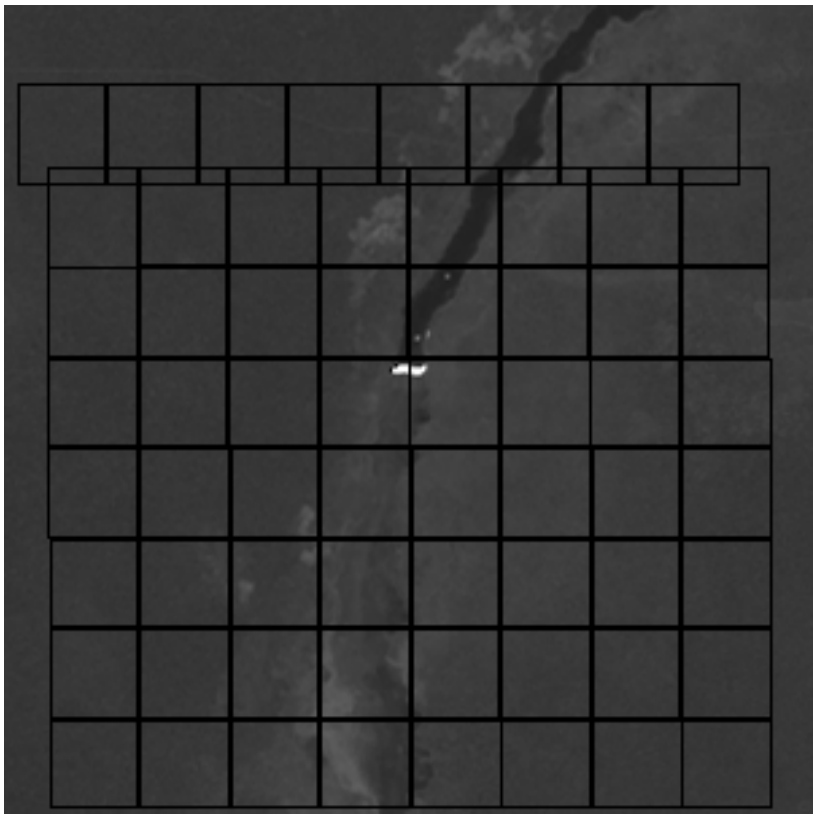
Fire fronts

Smoke

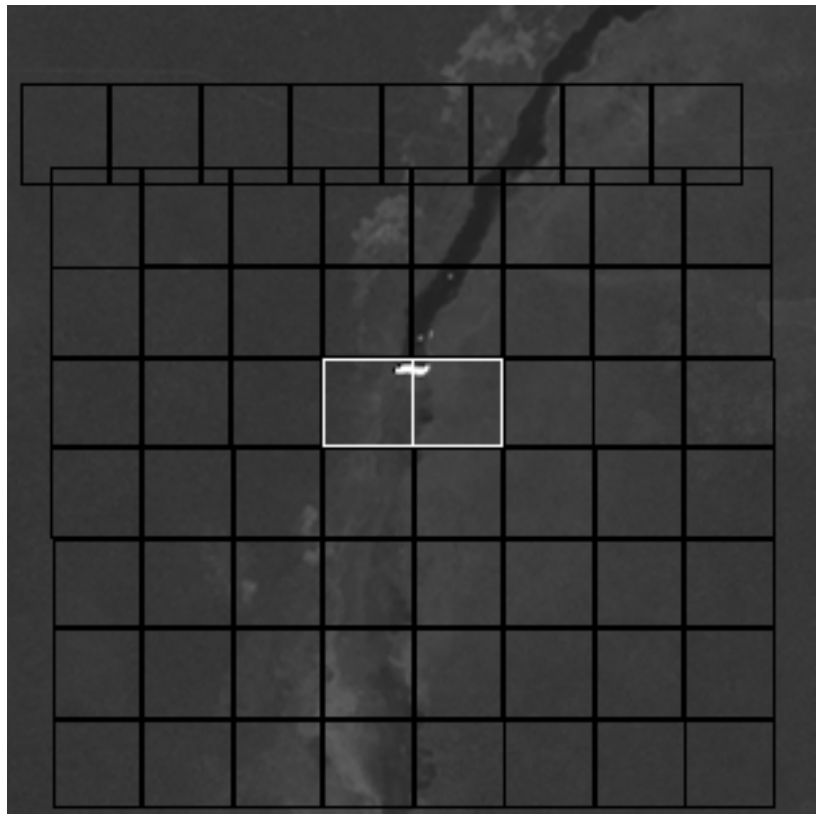
R: 2.16 µm
G: 1.65 µm
B: 0.56 µm

Effects of MODIS algorithm change

“Dambo” fire in Western Zambia, August 12 2001, 16.6S 24.4E.



Version 3

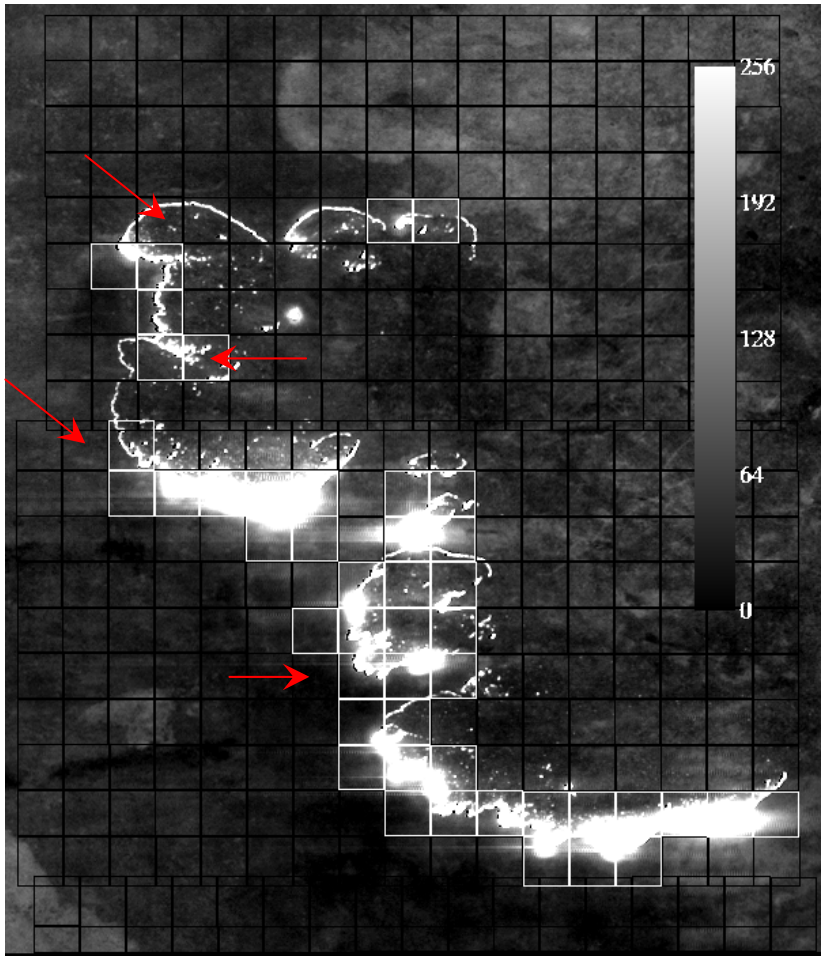


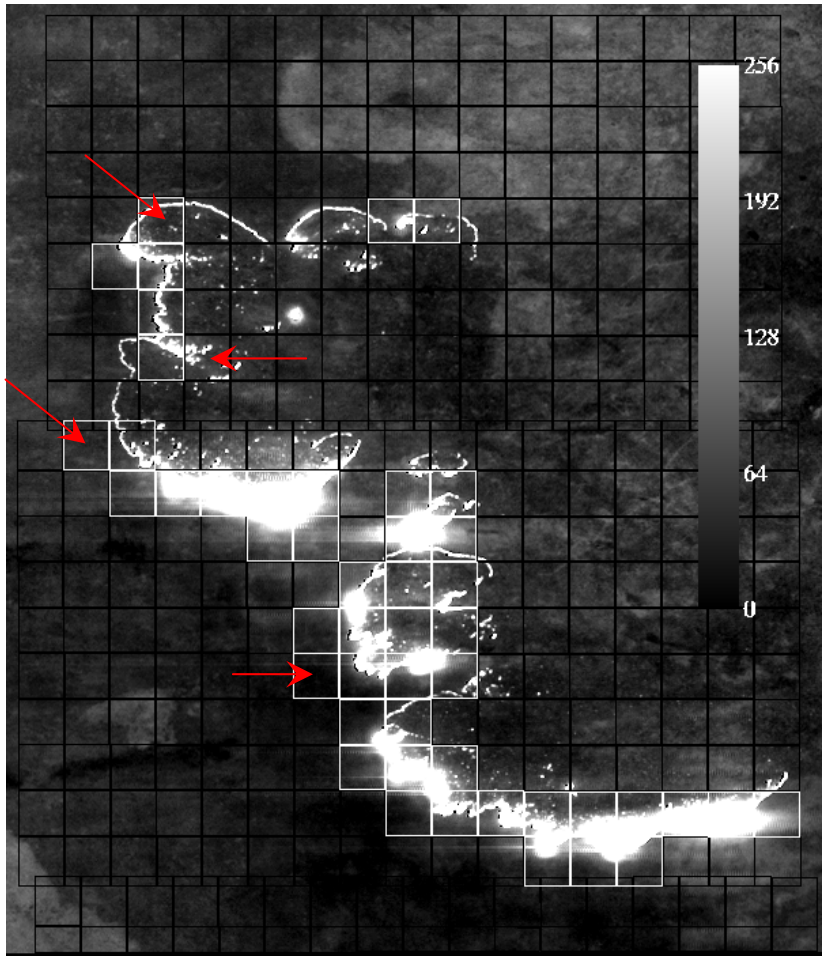
Version 4

ASTER channel 9 image. White squares show MODIS fire pixels.

Effects of MODIS algorithm change

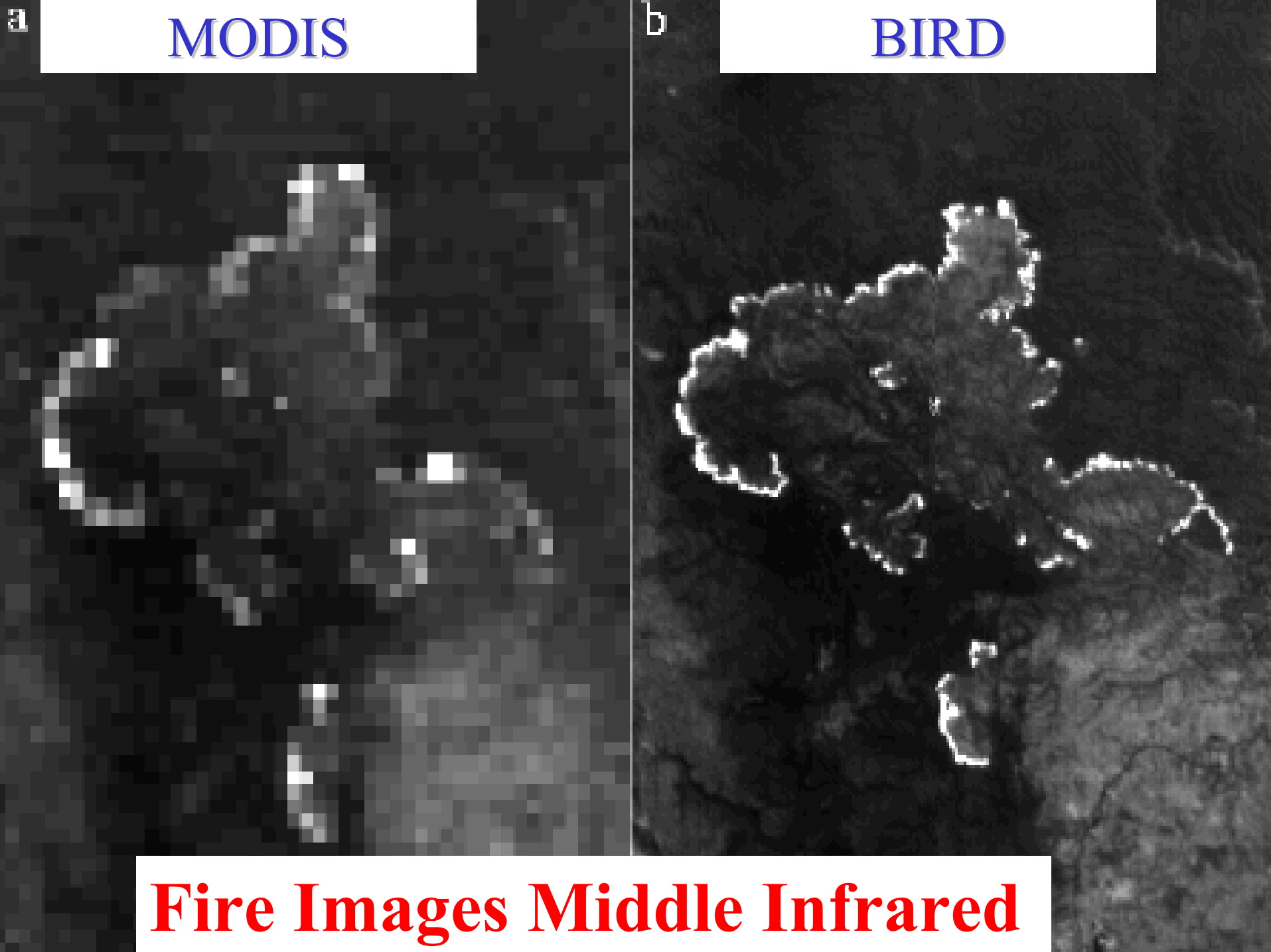
Fire front in NE Namibia, August 17 2001, 18.8S 19.9E





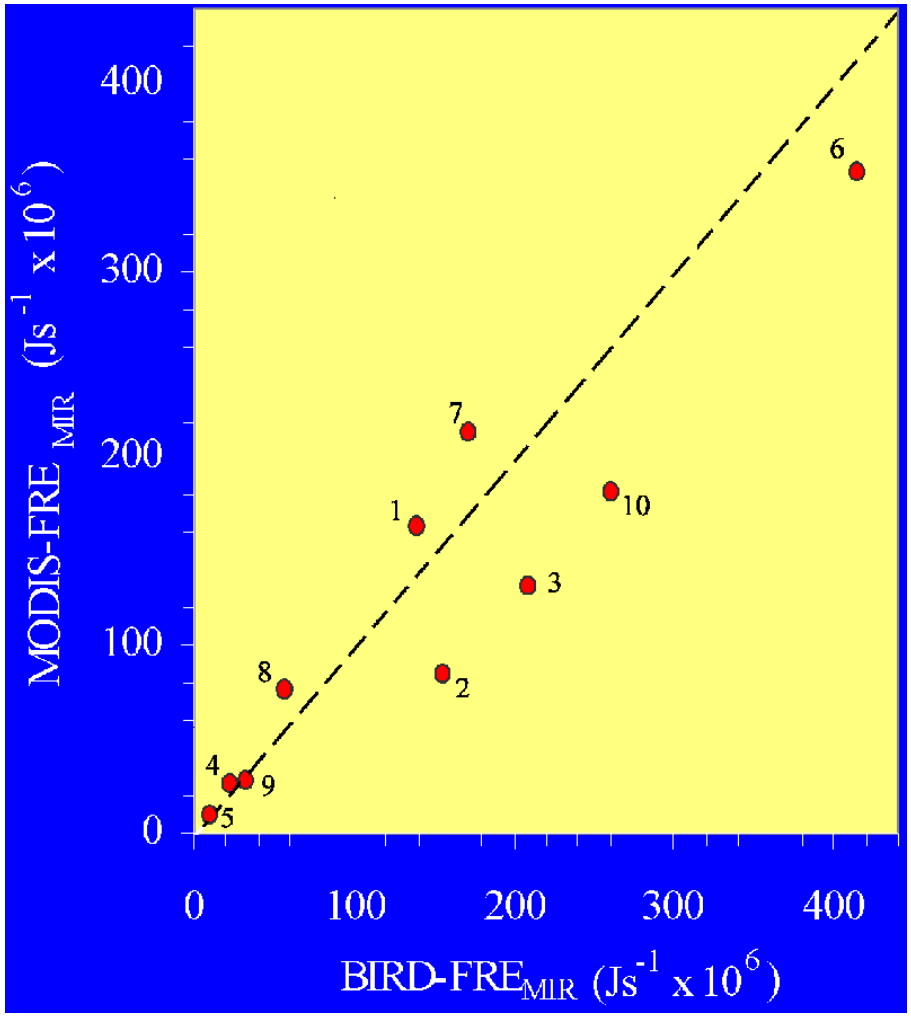
Version 3 **Version 4**

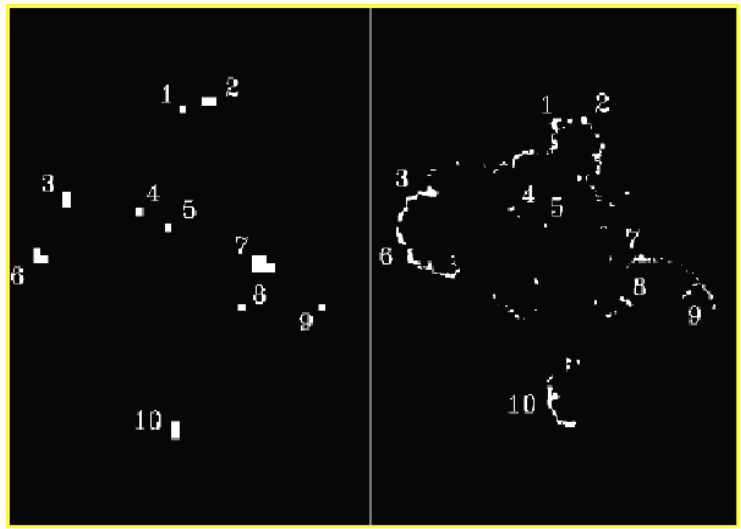
ASTER channel 9 image. White squares show MODIS fire pixels.



Fire Images Middle Infrared

MODIS ~ BIRD Fire Radiative Energy Comparison



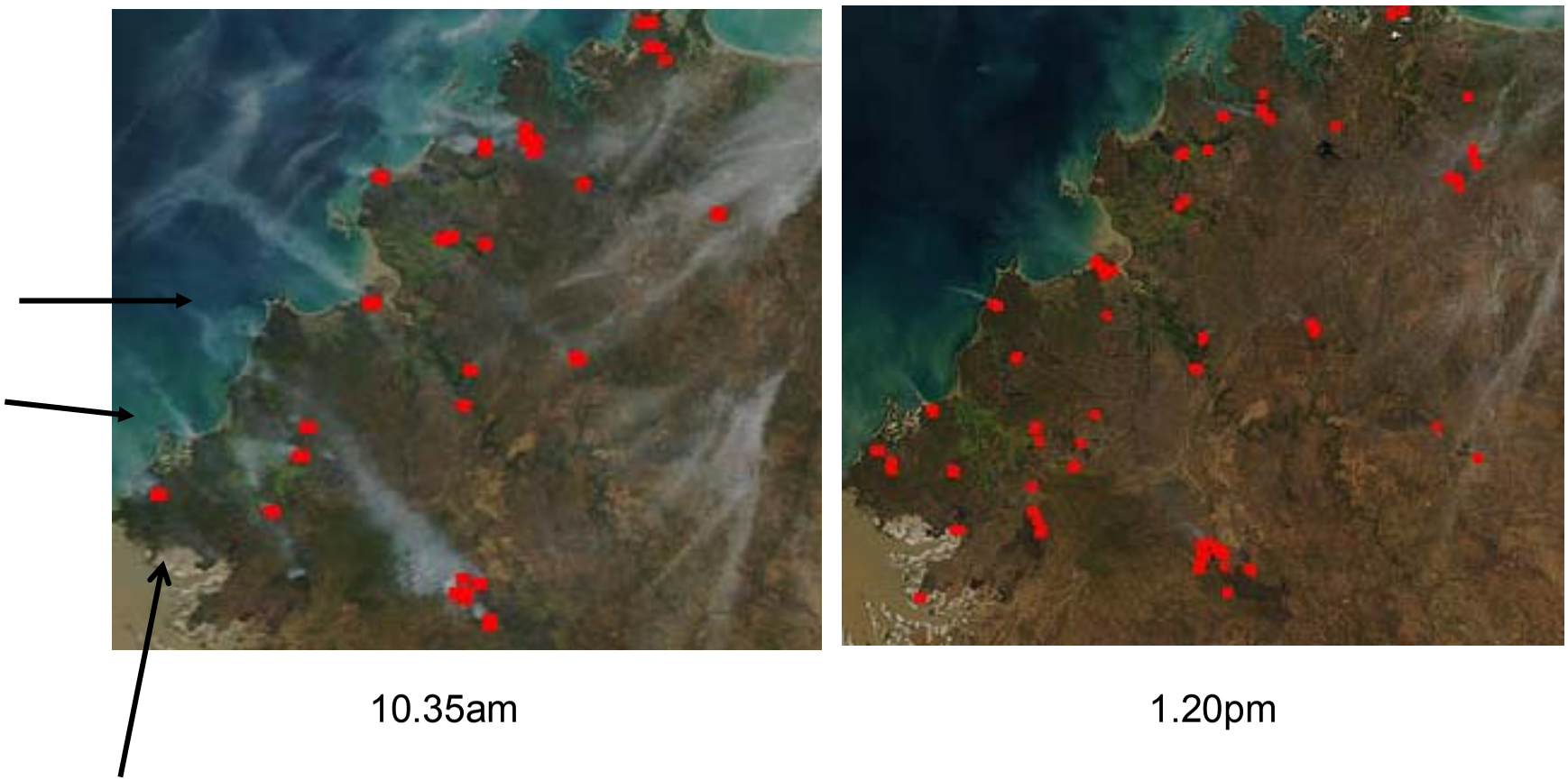


MODIS **BIRD**

M. Wooster,
(Dept. Geography, Kings College, London)

Launch of MODIS on Aqua Improves Coverage of Burning Period

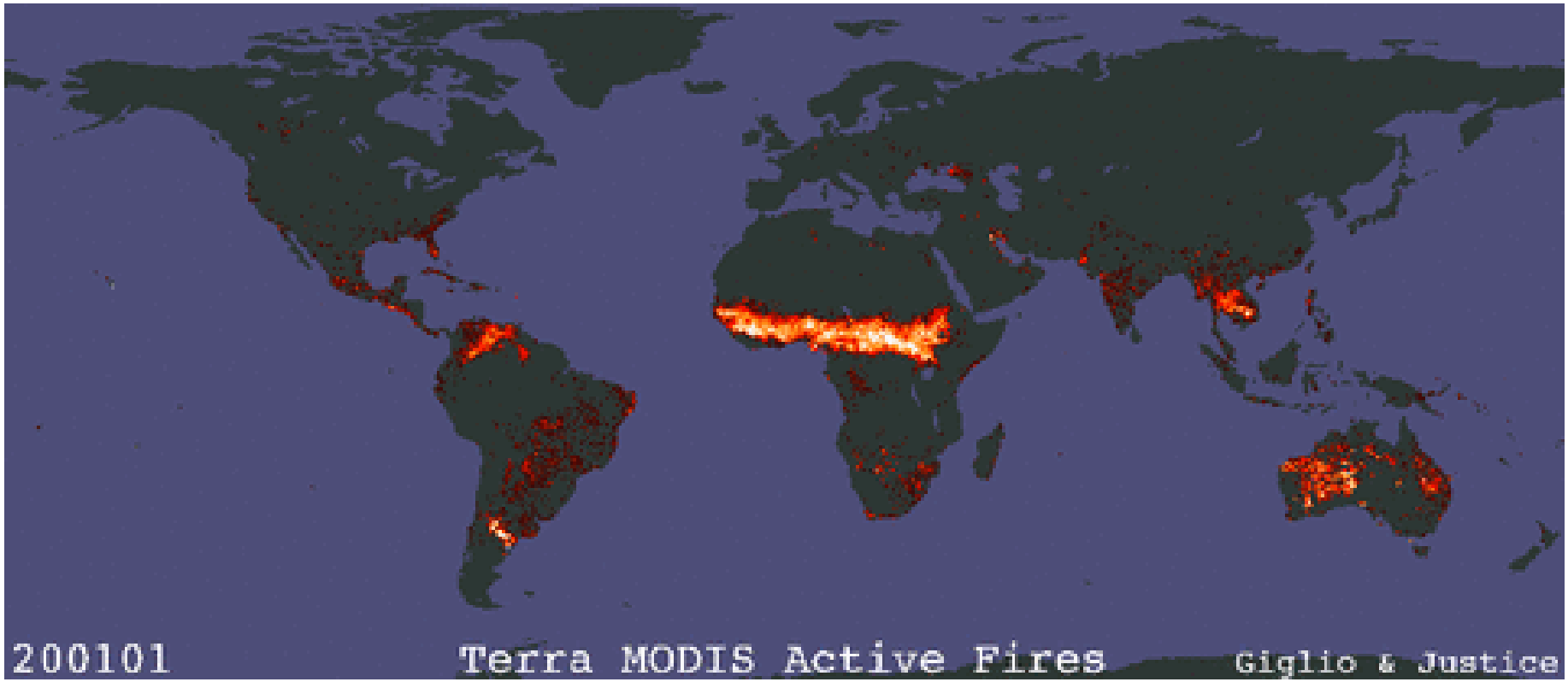
June 25th 2002



10.35am

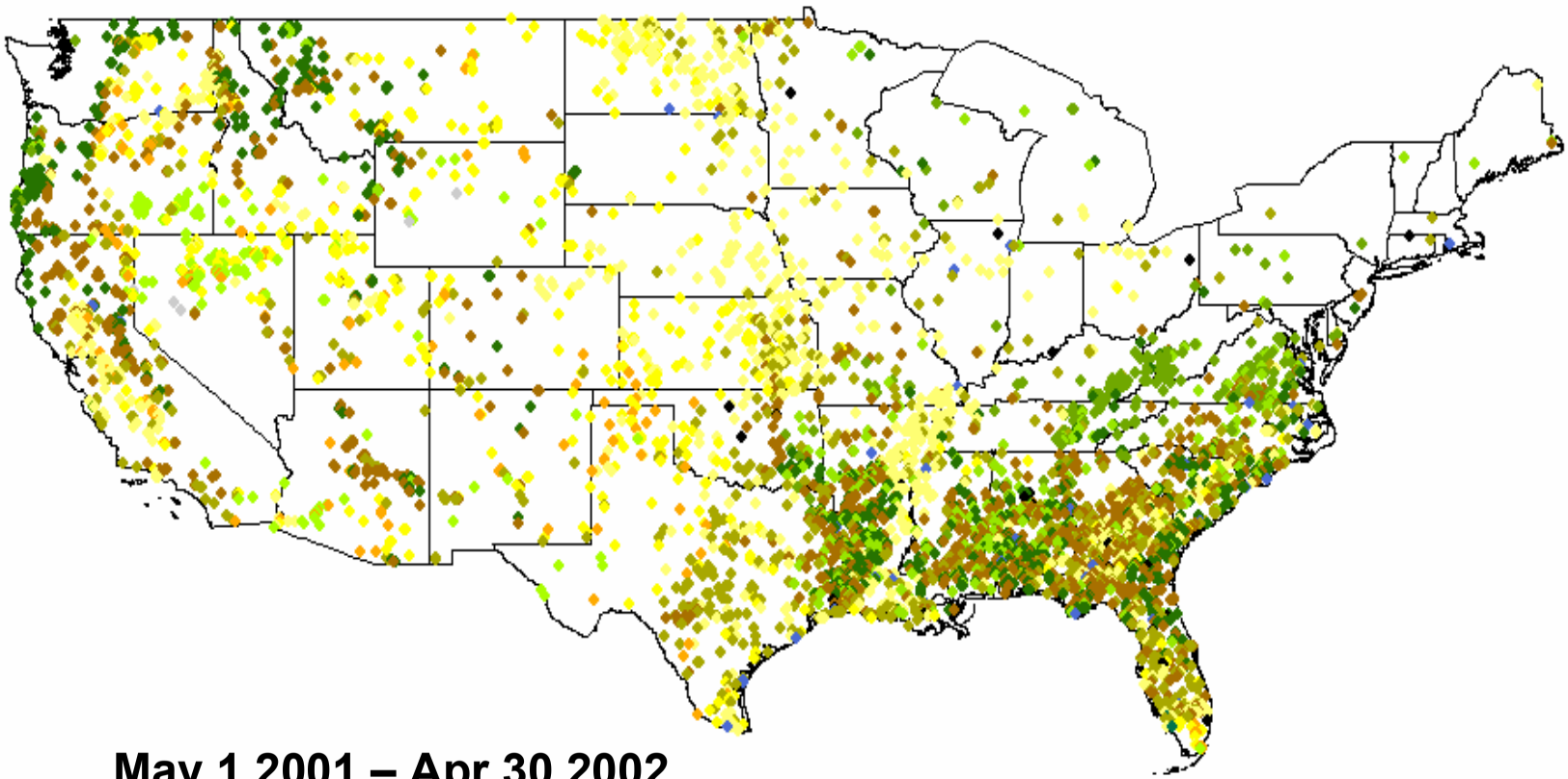
1.20pm

Summary of Terra MODIS Active Fires
2001 - 2003



click map to view movie

MODIS Land Rapid Response Fire Locations by Land Cover Type



May 1 2001 – Apr 30 2002

Color Coding by UMd Land Cover
Greens – Forested
Yellows/Browns – Grassland /Ag

From Research to Operations

MODIS Land Rapid Response System

- **Goal:**
  - 1) to meet science and applications user needs with respect to **rapid access** to MODIS data especially as related to wildfire management
  - 2) to provide **enhanced public outreach** for EOS and some of the unique capabilities of MODIS
- **Approach:**
  - 1) to develop a **flexible, streamlined and rapid MODIS processing and distribution** (data access) system with global coverage and value added products to augment the MODIS Standard Products
  - 2) **reuse** of software, hardware and expertise (esp. COTS)
  - 3) to undertake outreach and **develop applications partnerships with other federal agencies** to utilize the data and gain recognition and support for EOS (to date this includes USFS and USDA Foreign Ag. Service)
  - 4) provide **a user driven service** and **rapid prototyping**

Rationale for RR System

- System development driven by the need for rapid access (1 – 4 hrs) to MODIS data and the need to overcome the delay in obtaining climate data record information from core system
- The manual work-around for 2000 Fire Season (Montana) showed the need for a more automated system and a science led activity with close oversight on data quality – a clear demand for fire data from the USFS and other agencies
- An organized response to persistent requests from agency outreach offices for up-to-date imagery of topical events from around the world – global capability needed
- Respond to requests for MODIS product code for use with Direct Broadcast receiving stations

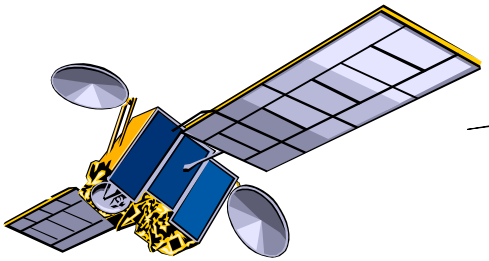
Rapid Response Data System Characteristics

- **Rapid Prototyping** – 3 month development
- **Reuse** of EDOS global feed to NOAA
- **Reuse of Hardware** from the ESIP supported 250m System
- **Reuse of Existing Software** development
  - Level 0 to 1B using IMAPP package (UW-Madison)
  - 250m Distribution System (MODLAND)
  - Global Browse (MODLAND QA Group)
- **System Flexibility and Responsiveness** dictated by
  - evolving understanding of the MODIS instrument – improving algorithms
  - maturing user understanding of the match between MODIS capabilities and user needs – responsive to user demand
  - allows new and improved algorithm testing
- **Open Source Code** packaging for Direct Broadcast users
  - Package now in use at USFS-RSAC and South Africa Disaster Network
  - Systems under development for Australia, Southern Europe, Mexico, Brazil
- **Uses COTS** development tools – Linux and ESRI mapping products

MODIS Rapid Response System: Overview

- Processing developed at NASA/GSFC using MODIS L0 data from NOAA (using existing "bent pipe" feed mechanism used to generate weather products)
- L0 processed with IMAPP software (DAAC processing modified for Direct Broadcast data) – Geolocation based on spacecraft attitude (no FDS attitude)
- Initial science products: Corrected Reflectance and Active Fire Detection
- No real-time ancillary data necessary
- Corrected Reflectance and active fire locations produced within ~ 4hrs of data acquisition over conterminous United States and sent to:
  - Rapid Response distribution web site: RGB Imagery + Active Fire Overlay
    http://rapidfire.sci.gsfc.nasa.gov
  - USFS/RSAC: Cumulative Fire Maps
    http://activefiremaps.fs.fed.us
  - Additional users at GeoMac, ESRI, Stormcenter.com, Reuters

MODIS Rapid Response Project Overview

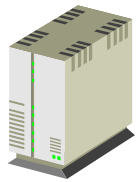


Terra

Direct Broadcast
Receiving Station

L1B Data

T+30min

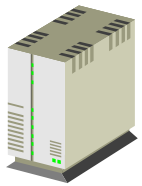


USDA Forest Service
Remote Sensing
Application Center

Active Fire Maps
http://activefiremaps.fs.fed.us
Three times per day

Backup Feed
L1B Data

EDOS



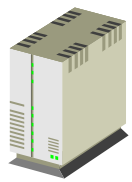
Rapid Response System
NASA/GSFC

Active Fire
Locations

T+5hrs

Burn Severity Maps
Handcrafted Imagery

Active Fire Locations
Selected Imagery

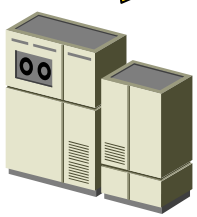


University of Maryland
Geography Dept

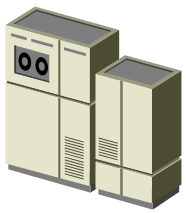
Active Fire
Locations
GOFC Fire Partners

MODIS
L0 Data

T+2-5hrs



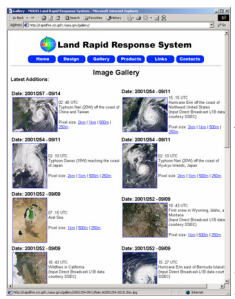
GES DAAC
NASA/GSFC



NOAA

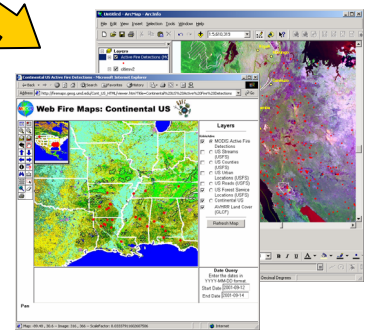
T+5hrs

NASA Earth
Observatory
http://earthobservatory.nasa.gov



Active Fire and
Corrected Reflectance
http://rapidfire.sci.gsfc.nasa.gov

MODIS home page
http://modis.gsfc.nasa.gov

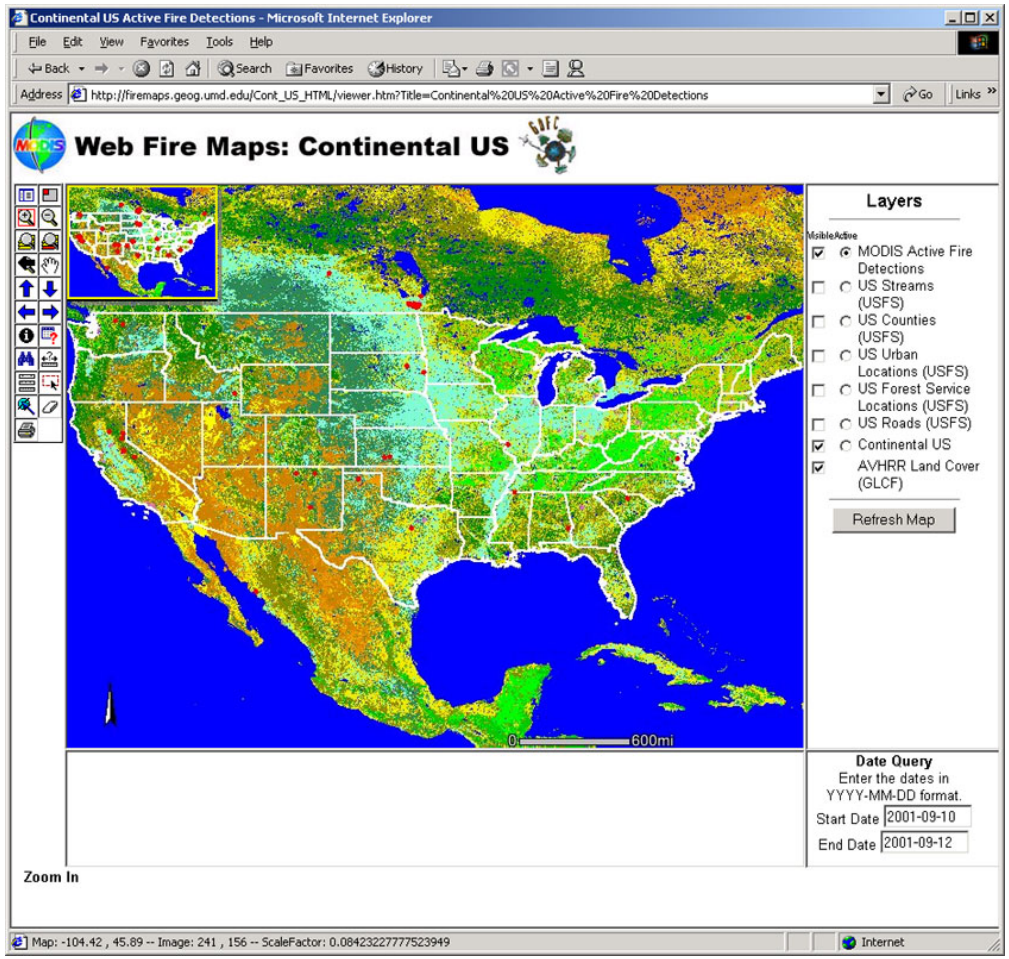


Web Fire Maps and Fire
Feature Server
http://firemaps.geog.umd.edu

Web Fire Maps

Regional interactive maps fusing derived Rapid Response products (e.g. active fire, land cover) with relevant GIS datasets (e.g. roads, political boundaries).

firemaps.geog.umd.edu



MODIS Direct Broadcast at USFS-RSAC

- SMARTech Explorer 2600
  - 3.1-meter, solid aluminum reflector
  - Integrated Feed / Low noise amplifier
  - X-band down converter
  - Gray Labs Receiver
  - Compaq Proliant Server
    - 1GHz Pentium III, 1GB RDRAM, 72GB RAID, 4mm tape, CDROM, High speed ingest card
    - Windows NT
    - SMARTrack Software
- 0.5TB RAID
- 350GB DLT7000 Tape Archive
- Compaq W6000 Workstation
  - Dual 1.7GHz Pentium IV, 1GB RDRAM
  - ERDAS Imagine
  - SMARTech ERDAS MODIS Module
- Linux Workstation – Rapid Response
  - Dual 1.2GHz Athlon, 2 GB RDRAM, 18 GB 10,000 rpm Ultrawide SCSI HD, 80 GB 7200 rpm EIDE HD.

USFS Remote Sensing Applications Center

Salt Lake City, Utah

• Provider of geospatial and remote sensing support to USFS and related agencies

National Interagency Fire Center

Boise, Idaho

• National coordination center for all federal and state wildfire resources

USFS Fire Science Lab, Rocky Mountain Research Station

Missoula, Montana

• Smoke forecasting and fire behavior research

Burned Area Emergency Rehabilitation Teams

• Federal inter-agency program to mitigate impacts on water quality and ecology

National Fire Maps - Netscape

File Edit View Go Communicator Help

Bookmarks Location: http://www.nifc.gov/firemaps.html What's Related

Home | FAQs | Site Map

National Fire Maps

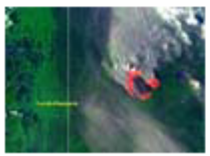
Large Fire Locations from the National Interagency Coordination Center at NIFC.

GeoMac: A multi-agency effort to bring together on-line, real-time information about wildland fires.

RSAC Fire Maps: These maps were compiled at the USDA Forest Service Remote Sensing Applications Center in cooperation with NASA Goddard Space Flight Center, the University of Maryland and the National Interagency Fire Center. The fire locations are mapped using imagery collected by the Moderate Resolution Imaging Spectroradiometer.

Wildland Fire Potential Assessment Map, July 19 - August 16, 2001: A map describing the wildland fire potential for areas throughout the country.

U.S. Drought Monitor: National Drought Mitigation Center



Fire Events: National Oceanic and Atmospheric Administration (NOAA) Fire Maps

Document: Done

Maps are Available to Fire Managers and Public

MODIS Rapid Response Fire Plots - Netscape

USDA Remote Sensing Application Center RSAC

MODIS Rapid Response Fire Map
Great Basin East GACC

These maps represent the fire extent as detected by MODIS. They are available as Adobe PDF files, JPEG images, and zipped RTL plots. Please see the instructions for more information.

Comments? Opinions? Let us know!

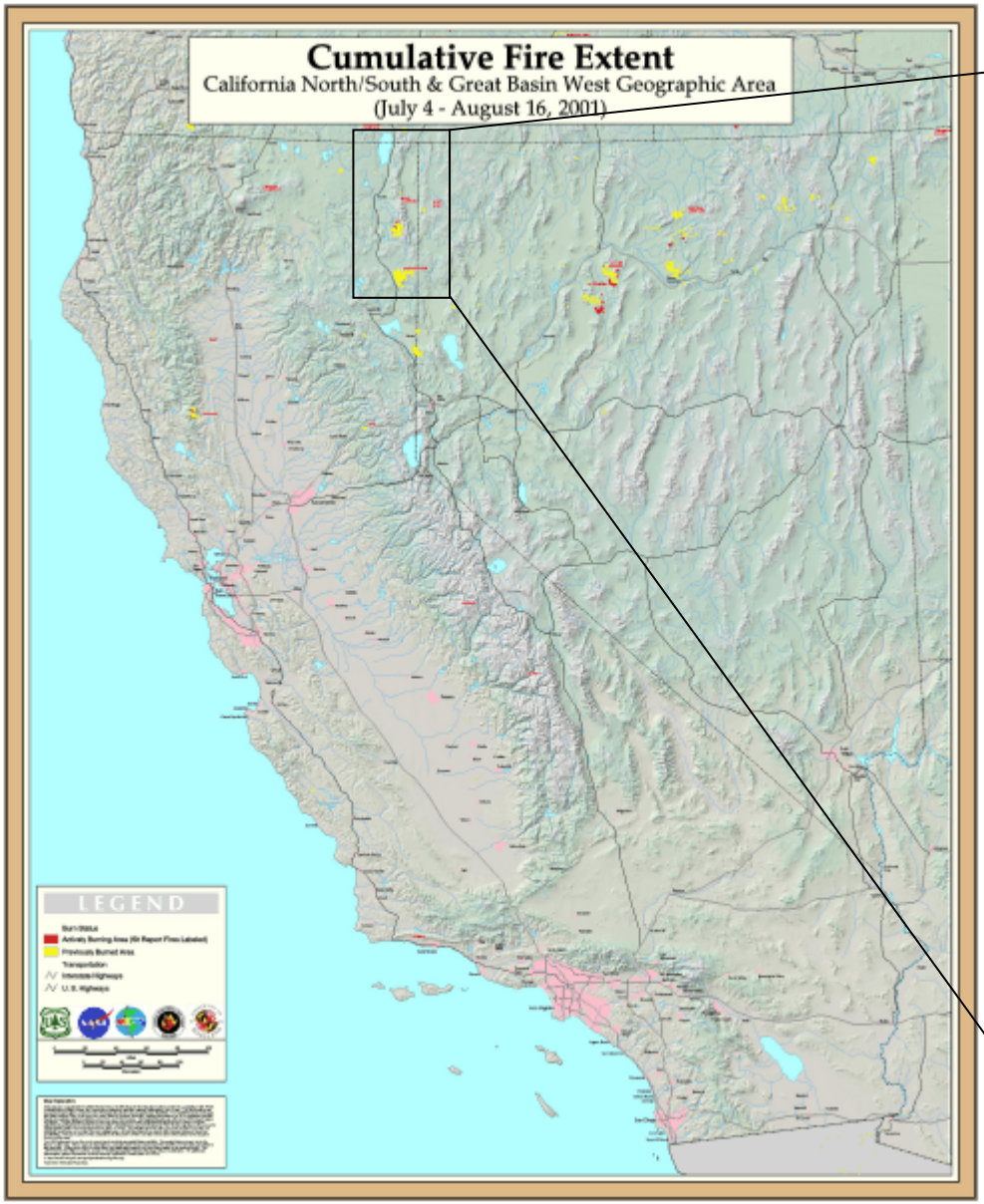
Most Current Map (9/13/2001)		
	PDF Plot	1.4 MB
	JPEG Image	2.7 MB
	Zipped RTL Plot	26.8 MB
Older Maps		
	Map Archive	

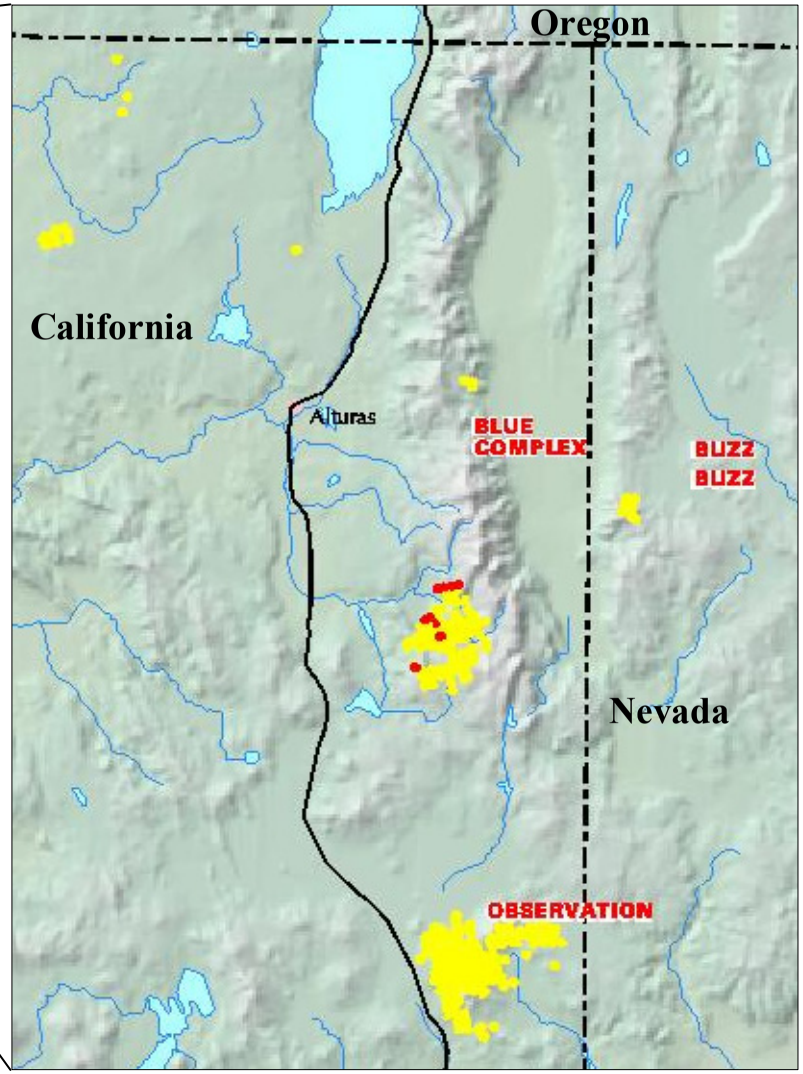
Note: These maps show the cumulative fire extent as of 9/13/2001.This includes day and nightime passes of MODIS.

Document: Done

Blue Complex Fire

16 August 2001



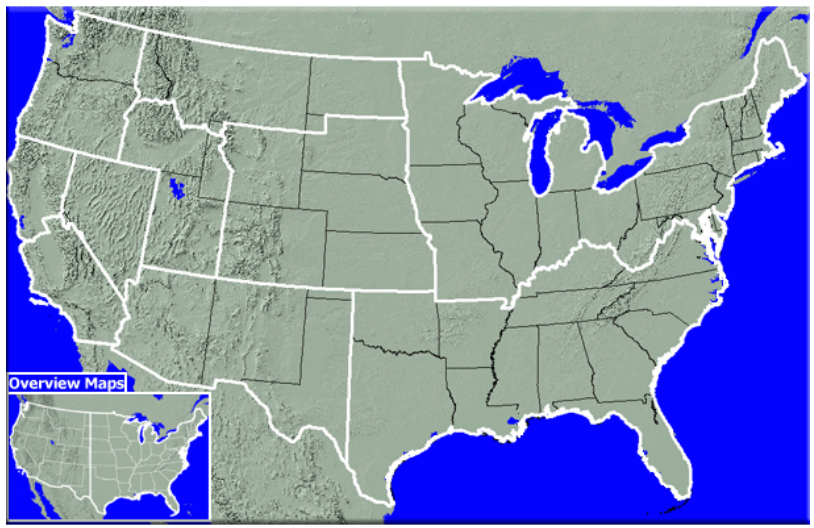


Active Fire in RED Previously Burned in YELLOW

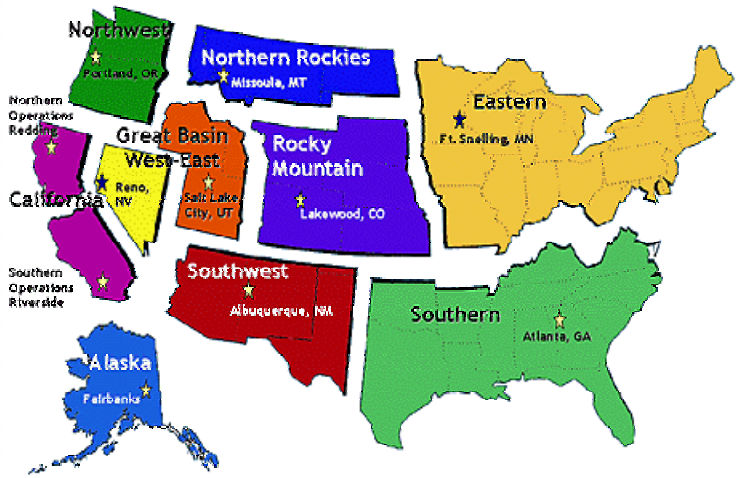
MODIS Rapid Response Data Distribution within the USFS

- Rapid Response fire points and imagery generated at GSFC and RSAC
- Fire points are ingested into a spatial database at UMD for ftp pull
- Imagery is sent to UMD and USFS for burn severity mapping
- The USFS-RSAC automatically produces active fire maps
- Fire maps are distributed via NIFC by 6am local time and two additonal
- The information is used at national and regional NIFC locations

MODIS Fire Map Regions



NIFC Geographic Coordination Areas



What is NIFC?

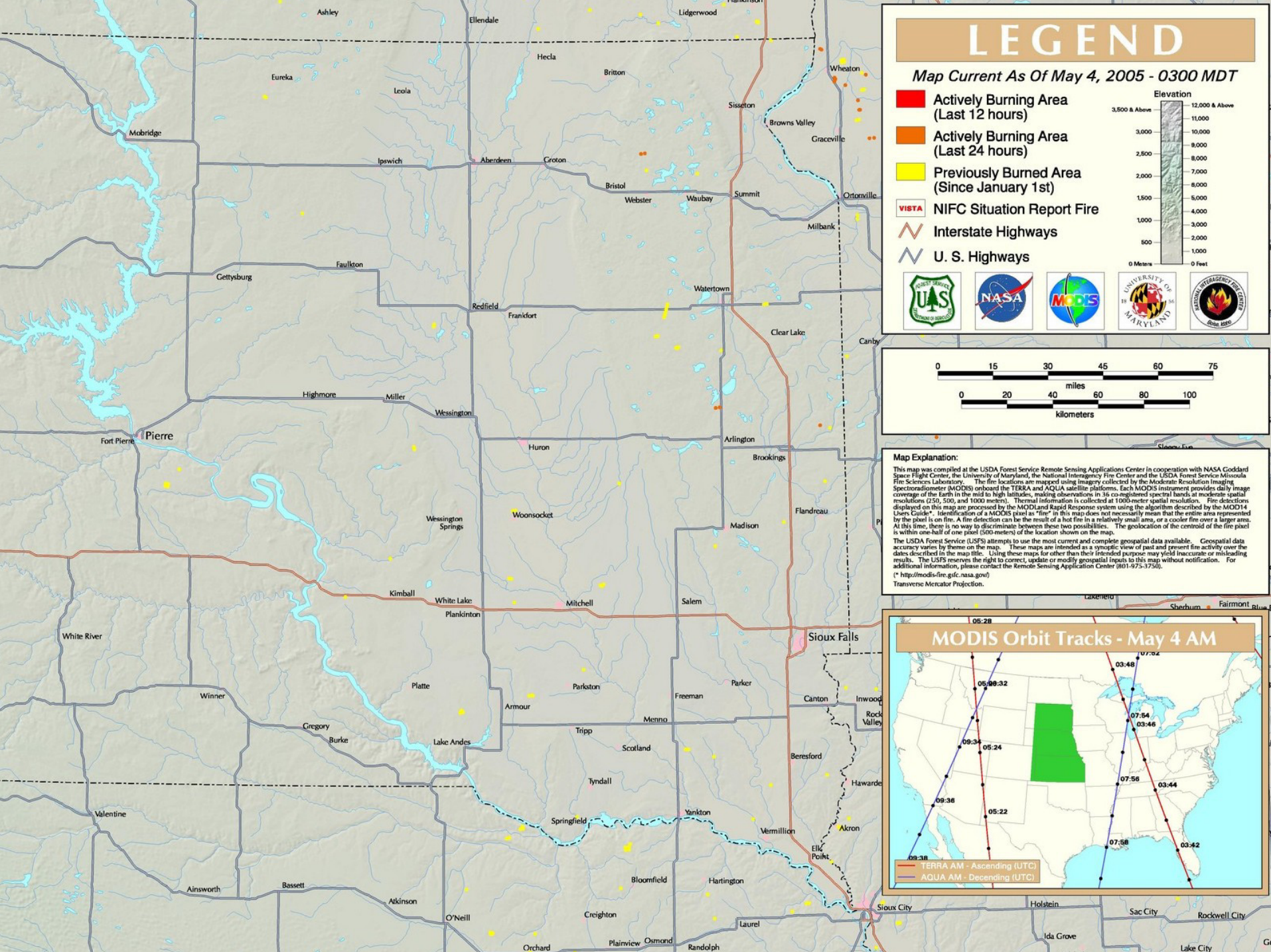
- Coordinates all federal response to wildfire
- Maintains large cache of equipment and supplies
- Allocates ground crews, air tankers, etc.
- Operates fleet of reconnaissance aircraft
- Evaluates new technology

Why is MODIS useful for fire management?

- Provides a new synoptic view at high resolution
- Avoids limitations of airborne platforms
  - Can't fly through heavy smoke
  - During crisis periods, flight hours are limited resource
  - MODIS provides full U.S. coverage 4X per day
- Previous work with higher-resolution (30m) instruments was limited by repeat cycle
- AVHRR is limited by saturation temperature
- Capability will transfer to VIIRS

Use within USFS and NIFC

- Strategic allocation of assets
  - This is different than tactical information
- Provides the “Big Picture” to planners
- Helps focus reconnaissance resources
- Provides rehabilitation specialists with a quick look, optimizing time on the ground


LEGEND
Map Current As Of May 4, 2005 - 0300 MDT
Actively Burning Area (Last 12 hours)
Actively Burning Area (Last 24 hours)
Previously Burned Area (Since January 1st)
VISTA NIFC Situation Report Fire
Interstate Highways
U. S. Highways
Elevation
3,500 & Above
3,000
2,500
2,000
1,500
1,000
500
0 Meters
12,000 & Above
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0 Feet
0 15 30 45 60 75
miles
0 20 40 60 80 100
kilometers
Map Explanation:
This map was compiled at the USDA Forest Service Remote Sensing Applications Center in cooperation with NASA Goddard Space Flight Center, the University of Maryland, the National Interagency Fire Center and the USDA Forest Service Missoula Fire Sciences Laboratory. The fire locations are mapped using imagery collected by the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard the TERRA and AQUA satellite platforms. Each MODIS instrument provides daily image coverage of the Earth in the mid to high latitudes, making observations in 36 co-registered spectral bands at moderate spatial resolutions (250, 500, and 1000 meters). Thermal information is collected at 1000-meter spatial resolution. Fire detections displayed on this map are processed by the MODLand Rapid Response system using the algorithm described by the MOD14 Users Guide*. Identification of a MODIS pixel as "fire" in this map does not necessarily mean that the entire area represented by the pixel is on fire. A fire detection can be the result of a hot fire in a relatively small area, or a cooler fire over a larger area. At this time, there is no way to discriminate between these two possibilities. The geolocation of the centroid of the fire pixel is within one-half of one pixel (500-meters) of the location shown on the map.
The USDA Forest Service (USFS) attempts to use the most current and complete geospatial data available. Geospatial data accuracy varies by theme on the map. These maps are intended as a synoptic view of past and present fire activity over the dates described in the map title. Using these maps for other than their intended purpose may yield inaccurate or misleading results. The USFS reserves the right to correct, update or modify geospatial inputs to this map without notification. For additional information, please contact the Remote Sensing Application Center (801-975-3750).
(* http://modis-fire.gsfc.nasa.gov/)
Transverse Mercator Projection.
MODIS Orbit Tracks - May 4 AM
05:28
03:48
05:28:32
07:54
03:46
09:34
05:24
07:56
03:44
09:36
05:22
07:58
03:42
09:38
TERRA AM - Ascending (UTC)
AQUA AM - Decending (UTC)
Ashley
Ellendale
Lidgerwood
Hecla
Britton
Wheaton
Eureka
Leola
Sisseton
Browns Valley
Graceville
Mobridge
Ipswich
Aberdeen
Groton
Bristol
Webster
Waubay
Summit
Ortonville
Milbank
Faulkton
Gettysburg
Watertown
Redfield
Frankfort
Clear Lake
Canby
Highmore
Miller
Wessington
Pierre
Fort Pierre
Huron
Arlington
Brookings
Wessington Springs
Woonsocket
Madison
Flandreau
Kimball
White Lake
Mitchell
Salem
Plankinton
White River
Sioux Falls
Platte
Parkston
Parker
Winner
Armour
Freeman
Canton
Inwood
Menno
Gregory
Burke
Tripp
Lake Andes
Scotland
Beresford
Tyndall
Hawarden
Valentine
Springfield
Yankton
Vermillion
Akron
Elk Point
Bloomfield
Hartington
Ainsworth
Bassett
Atkinson
O'Neill
Creighton
Laurel
Sioux City
Holstein
Sac City
Rockwell City
Ida Grove
Orchard
Plainview
Osmond
Randolph

Reaction from USFS Managers

- First time daily synoptic view has been available
- Positive comments from NIFC, WO Fire Desk, regional foresters, Fire and Aviation Division, Secretary Of Agriculture, President's Budget Request
- Much interest in growing the suite of applications
  - Fire risk
  - Monitoring illegal logging
  - Range management
  - International division

http://activefiremaps.fs.fed.us

Post-Fire Management

The goal of BAER mapping …

Identify those areas at greatest risk for adverse impacts on water quality and re-generation due to factors such as the formation of hydrophobic soils

which can result in severe erosion.

This must be done quickly and over large areas. Remote sensing is of great value to help rapidly focus on those areas with the most critical need.

unburned area
Unburned landscape near the Eyerly Fire in Oregon, showing the wide variety of potential fuels, from the grasses in the foreground, to the low shrubs at the entrance of the heavily wooded areas beyond. In assessing burn severity, scientists consider the impact of fire on various vegetation types as one of many factors.

low burn severity
A low-severity burned landscape from Oregon's Winter Fire in summer 2002. Sage and scattered small trees covered this open area. Although the sage burned, it still has root mounds in place, and the trees are still standing and only slightly scorched.

moderate burn severity
A moderate-severity burned landscape at the site of Oregon's Biscuit Fire in the summer of 2002. Foliage on the trees is scorched, but not completely consumed. What remains provides for "needle-cast," in which the dead needles will drop, creating a layer of protective mulch on the forest floor.

high burn severity
A landscape near the Eyerly Fire in Oregon showing a high-severity burn. Trees are blackened and all foliage has been burned from the trees. All understory vegetation has been consumed.

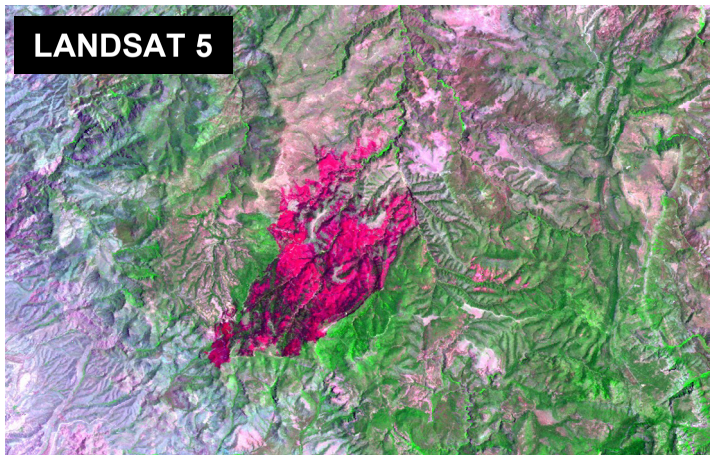
Assessing Burn Severity

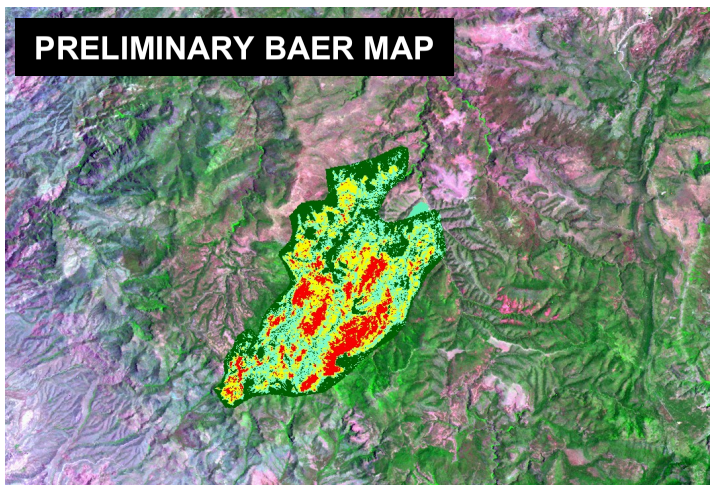
- Terra & Aqua MODIS provide 250m imagery on a twice daily time-step
- This provides an overview of burn scars and unburned islands
- Fine resolution data is then acquired to map burn severity for rehabilitation planning
- Can use a variety of instruments:
  - **Quickbird (0.61m - 2.44m)**
  - **IKONOS (1m - 4m)**
  - **Spot (2.5m - 10m)**
  - **Landsat 7 (15m - 30m)**
  - **ASTER (15m - 30m)**
- With finer spatial resolution, re-visit time is longer (i.e. 16 days for Landsat)
- Airborne platforms can also be tasked on-demand
  - **for example, ER2 flying MAS/MASTER; a UAV flying AirDAS, etc.**

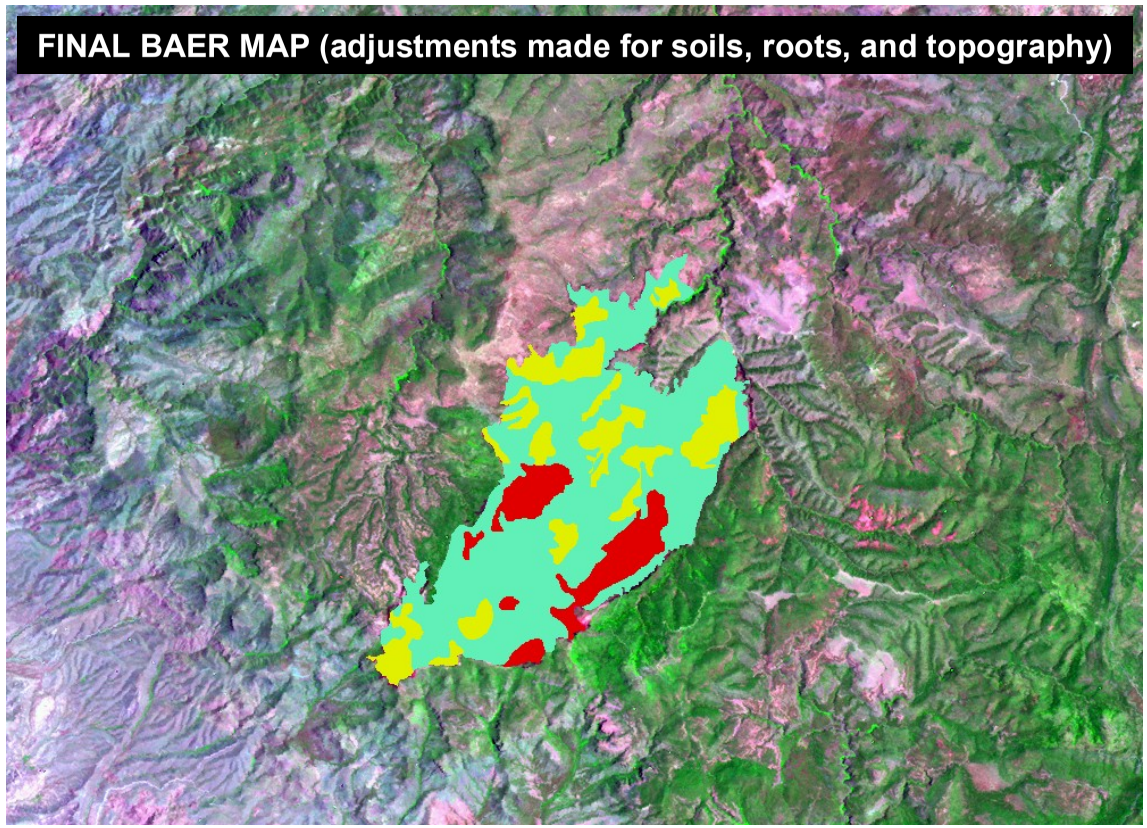
BURNED AREA EMERGENCY REHABILITATION MAP FROM HIGH RESOLUTION INSTRUMENTS

Picture Fire, Tonto National Forest, June 2003

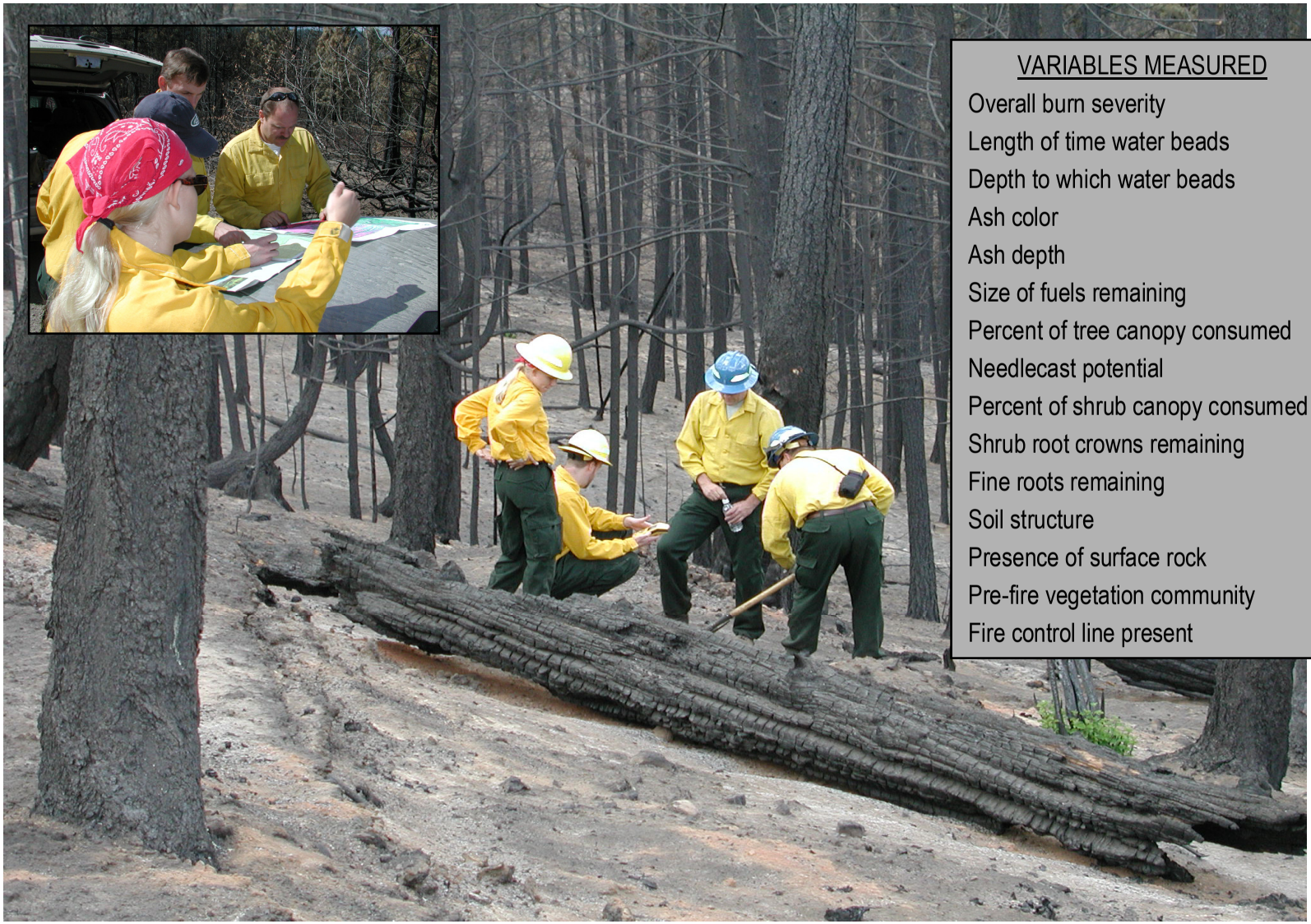
BAER teams are composed of soil scientists, hydrologists, wildlife biologists, and foresters. They may also include civil engineers and archeologists. Their charge is to prepare a preliminary rehabilitation plan within 7 days and a final plan within 14 days of a fire being contained. These plans determine the effort which will be needed to stabilize soils, control invasive species, preserve water quality, and return the forest to a healthy condition. Because large areas are involved, wisely prioritizing these efforts results in efficient allocation of taxpayer funds. High resolution remote sensing provides a quick look which allows the BAER team to make best use of limited time. Satellite results are then refined.







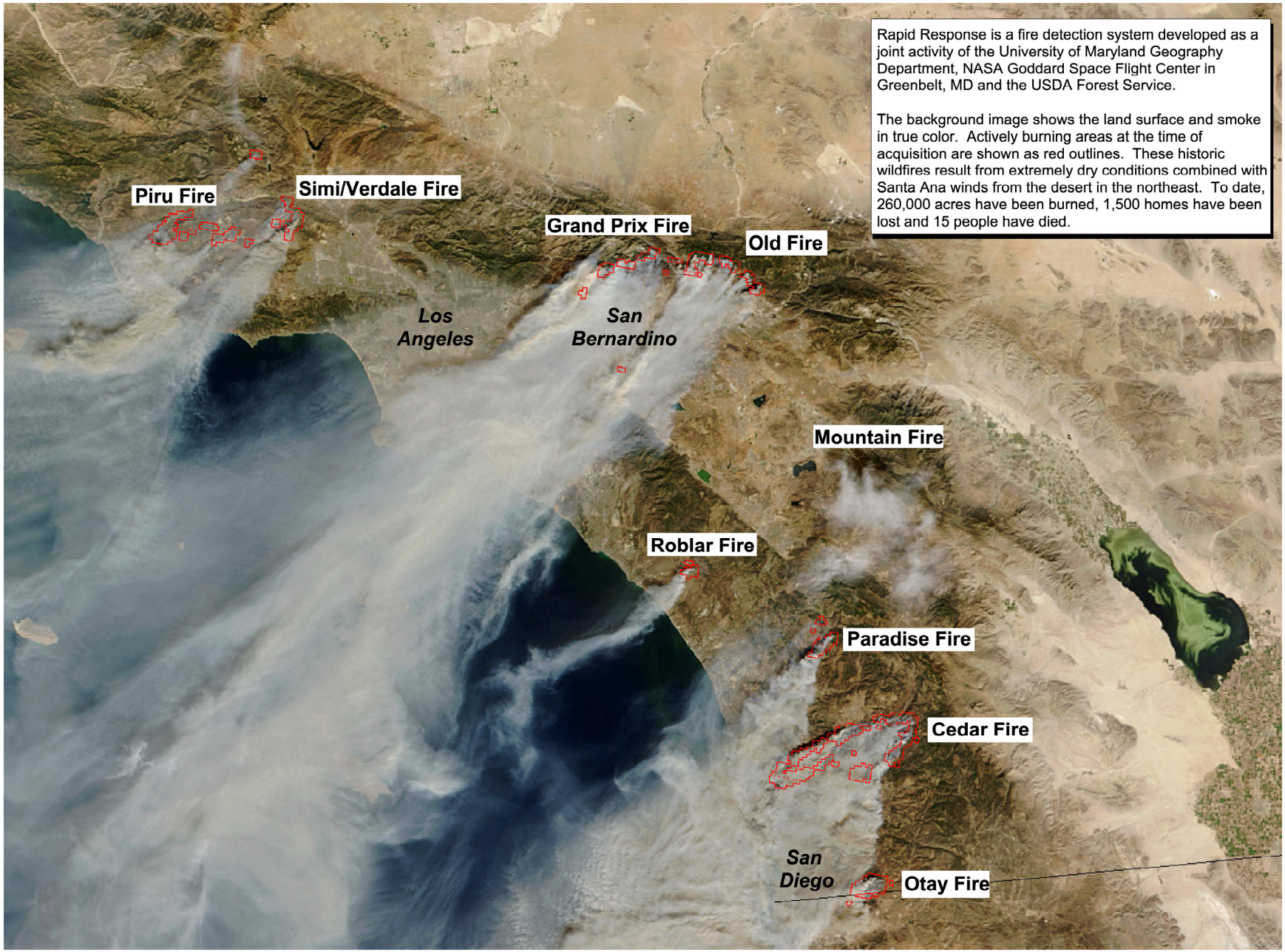
NASA investigators work collaboratively with USFS to refine BAER methods and assess accuracy. Listening to fire managers on the ground is key.



VARIABLES MEASURED

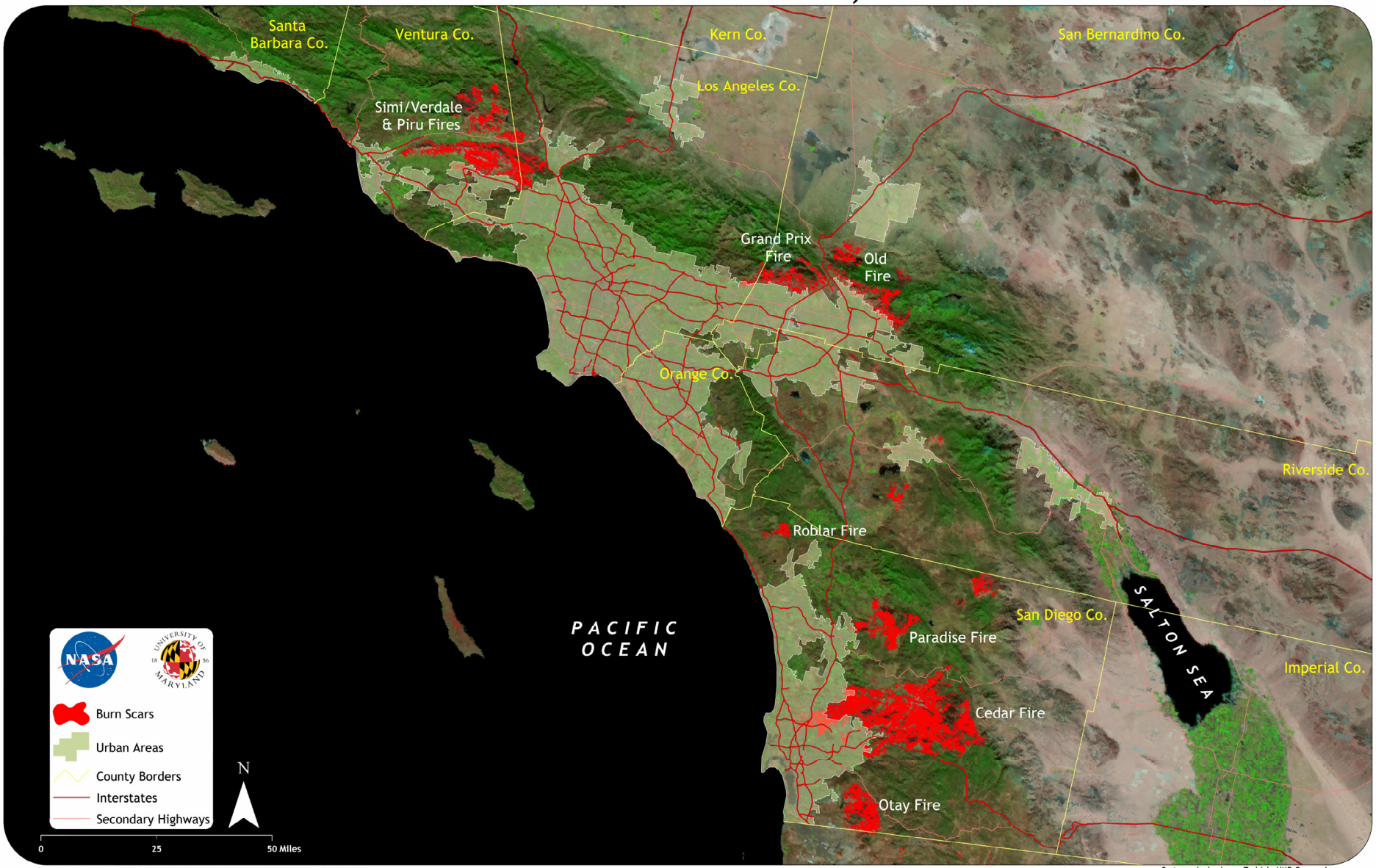
- Overall burn severity
- Length of time water beads
- Depth to which water beads
- Ash color
- Ash depth
- Size of fuels remaining
- Percent of tree canopy consumed
- Needlecast potential
- Percent of shrub canopy consumed
- Shrub root crowns remaining
- Fine roots remaining
- Soil structure
- Presence of surface rock
- Pre-fire vegetation community
- Fire control line present

California Wildfires as seen by MODIS Rapid Response (10/26/2003)



Imagery: http://rapidfire.sci.gsfc.nasa.gov
Layout and design: James Tedrick, UMD Geography

Burn Scars in Southern California, Winter 2003

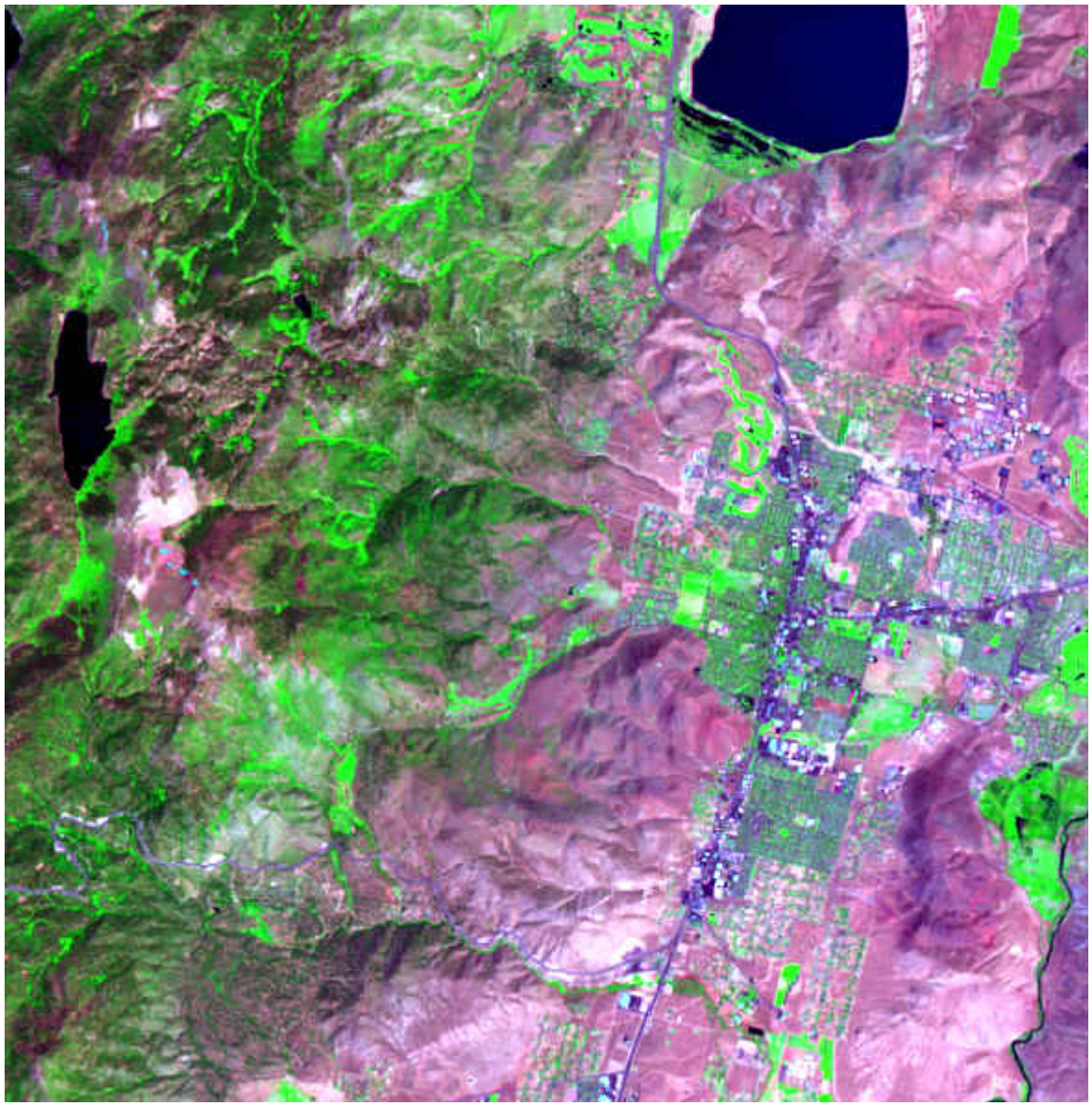


Data Sources: NASA MODIS 250m data processed byUMD Department of Geography, 2004
Environmental Research Systems Institute. ESRI Data and Maps 2003. Redlands, CA: Author.

Cartography by James Tedrick, UMD Geography
2/5/2004

Imagery and BARC

Pre-fire

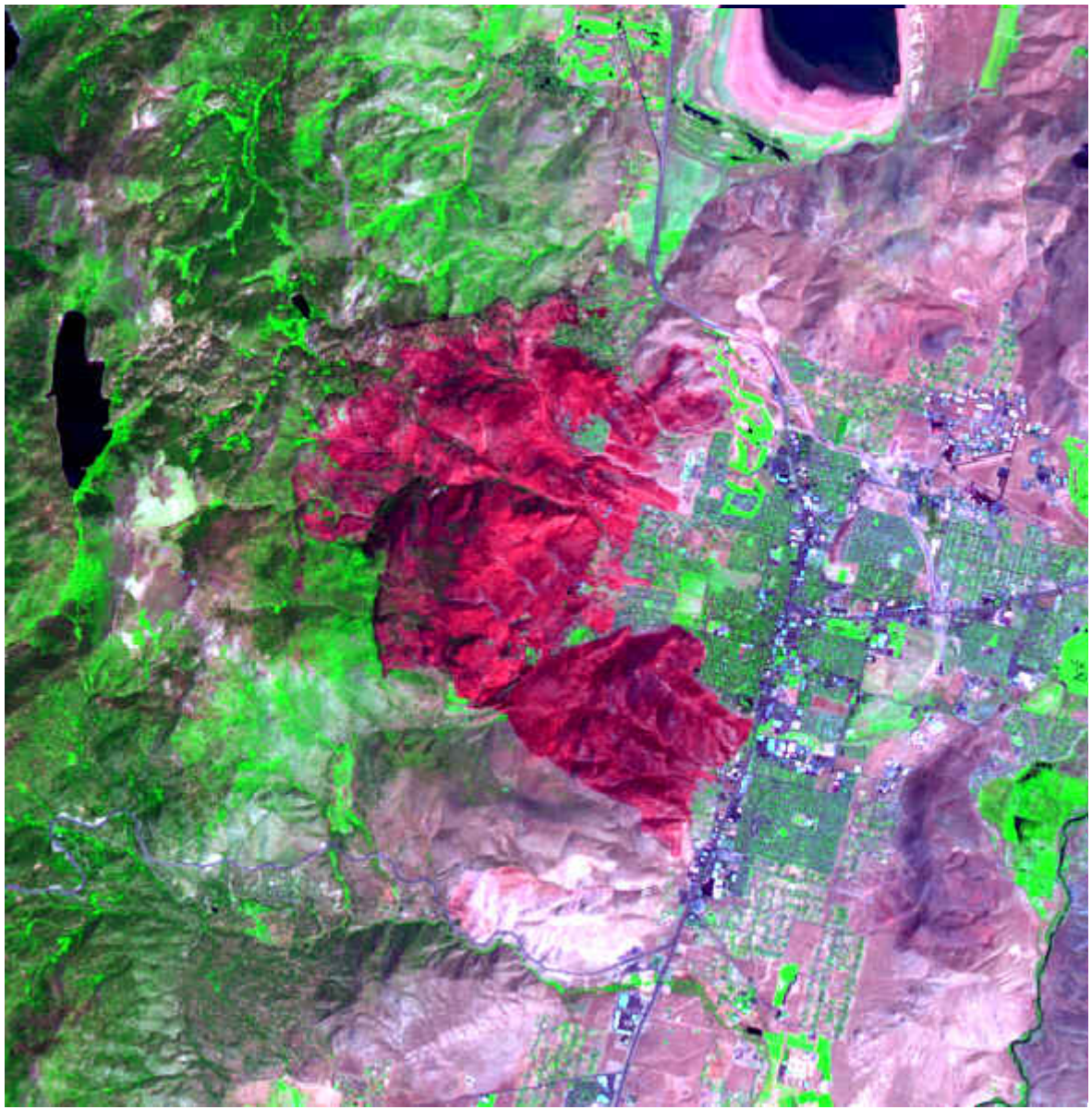


Continued

Imagery and BARC

Pre-fire

Post-fire



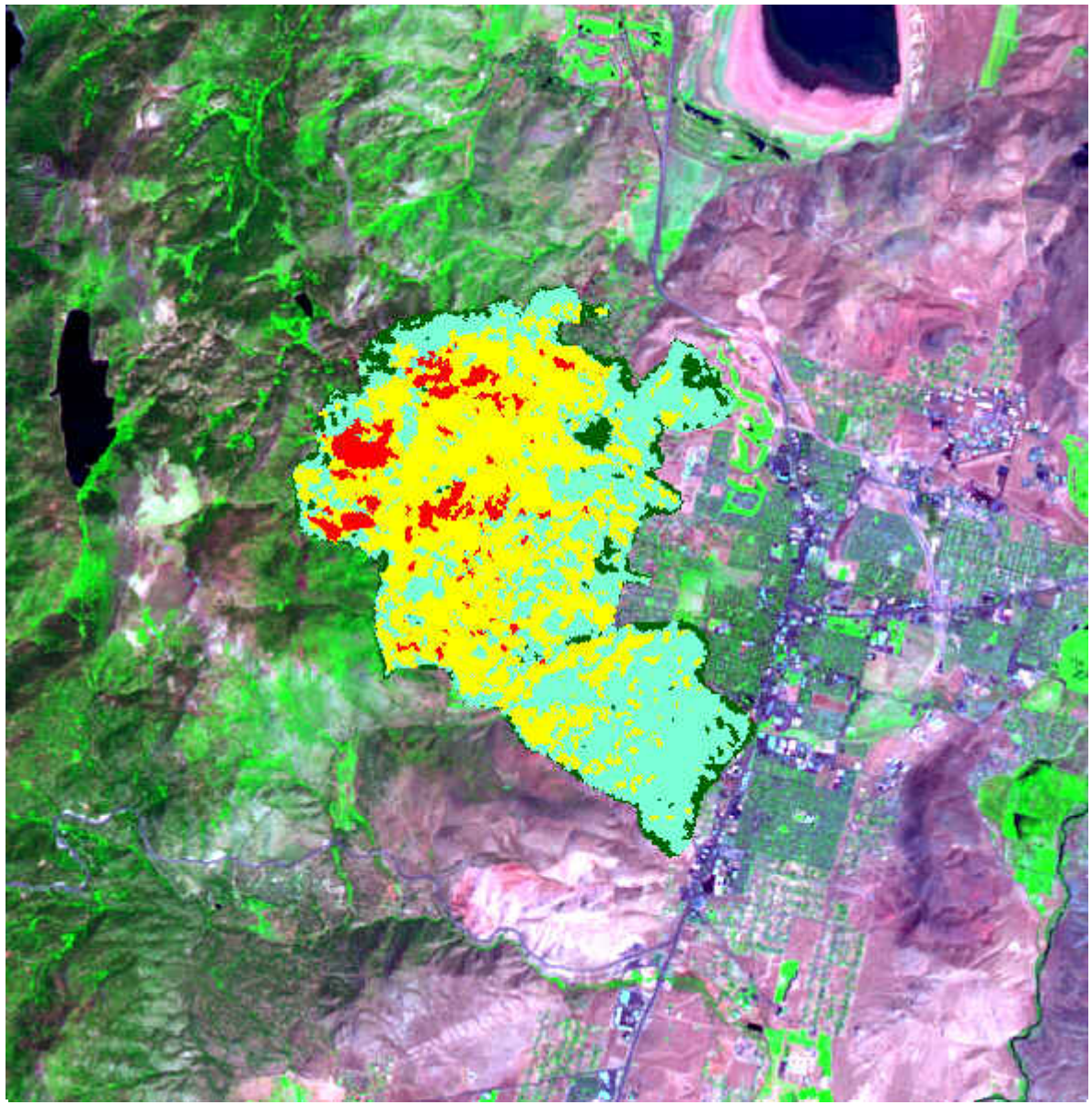
Continued

Imagery and BARC

Pre-fire

Post-fire

Burned Area Reflectance Classification

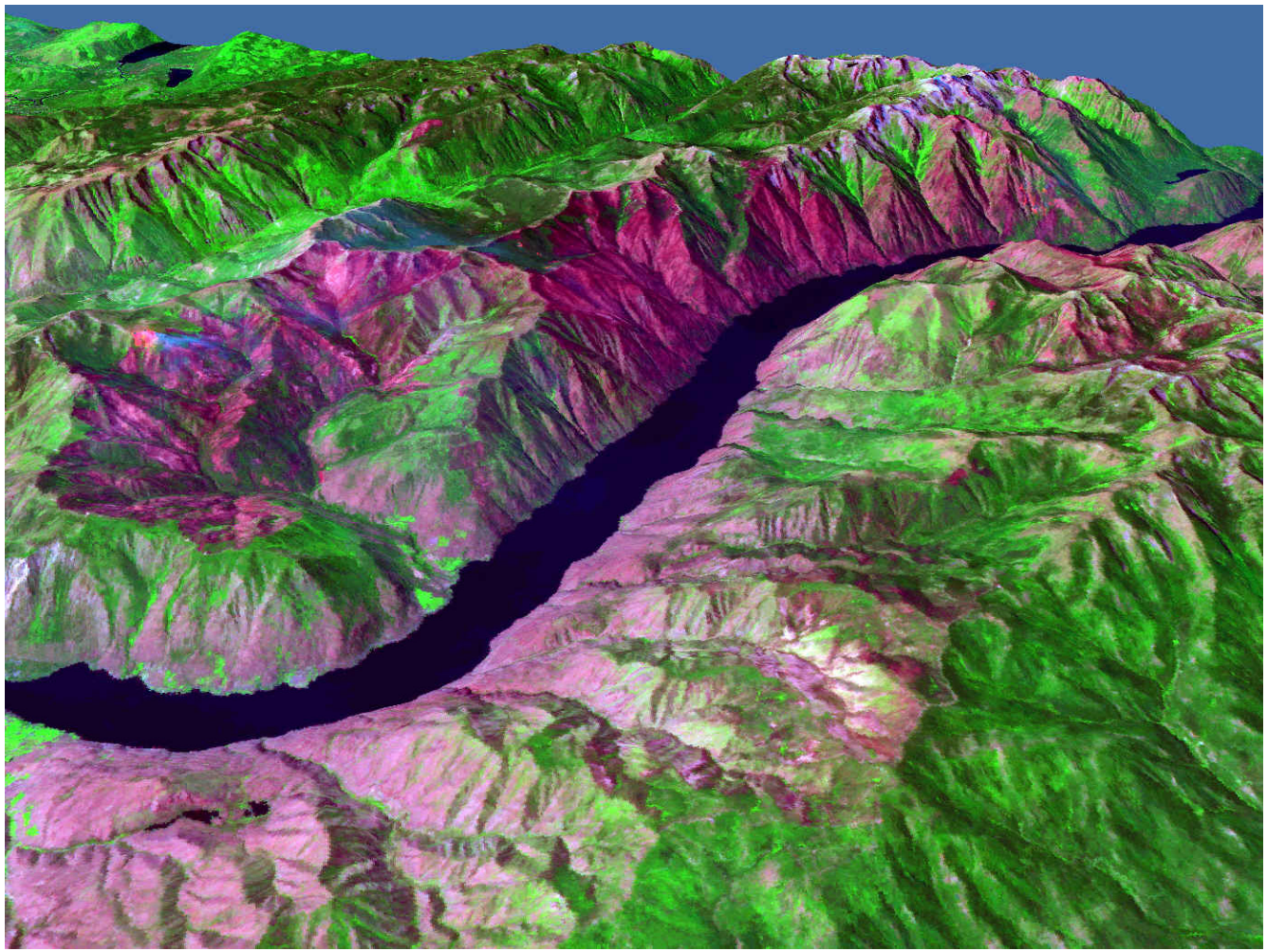


Thresholds Applied to Create Distinct Classes

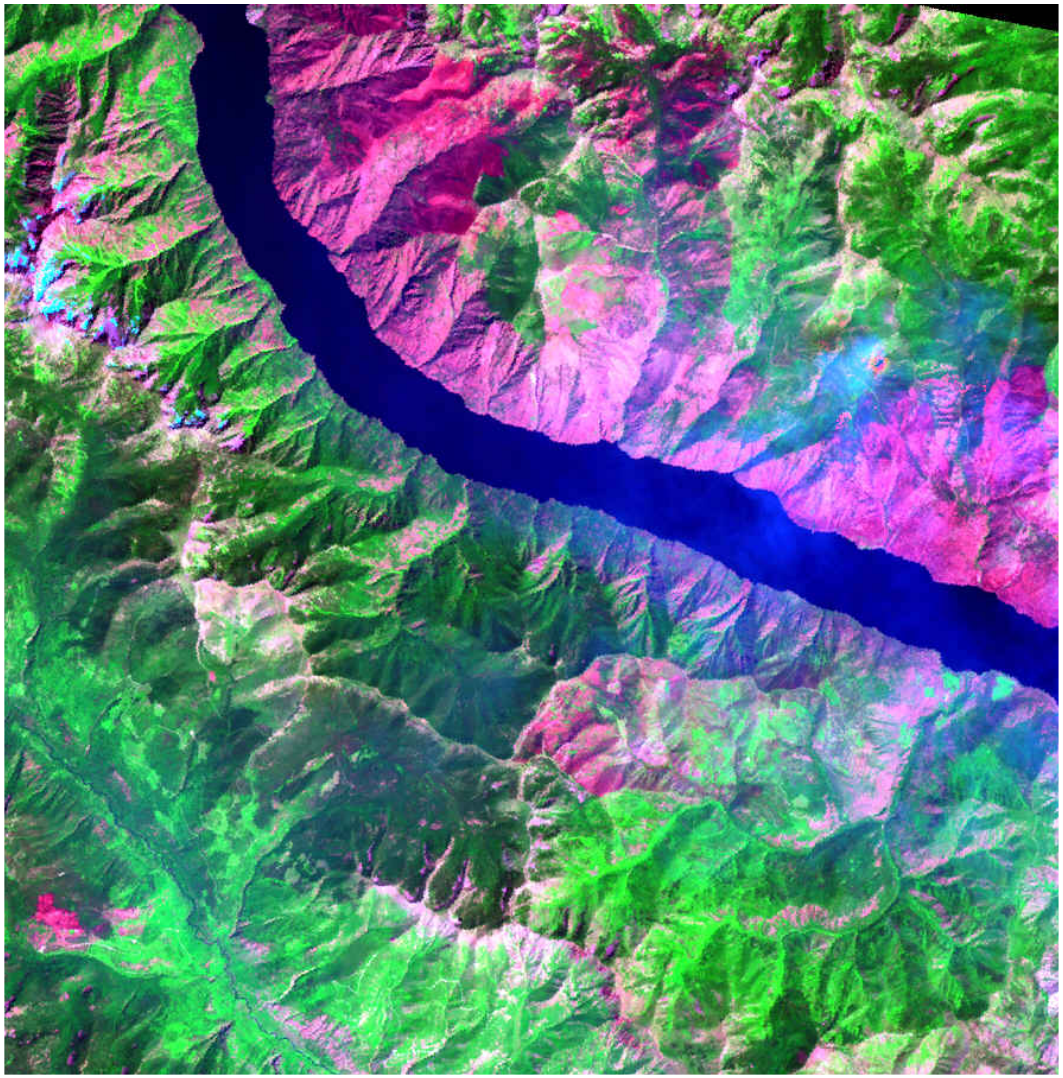
- High
- Moderate
- Low
- Very Low / Unburned

Pot Peak / Sisi Ridge Complex

Region 6 – Chelan Ranger District, Okanogan-Wenatchee NF
Fire burned right on Lake Chelan, across from 2002 Deer Point Fire.



Pot Peak / Sisi Ridge Complex



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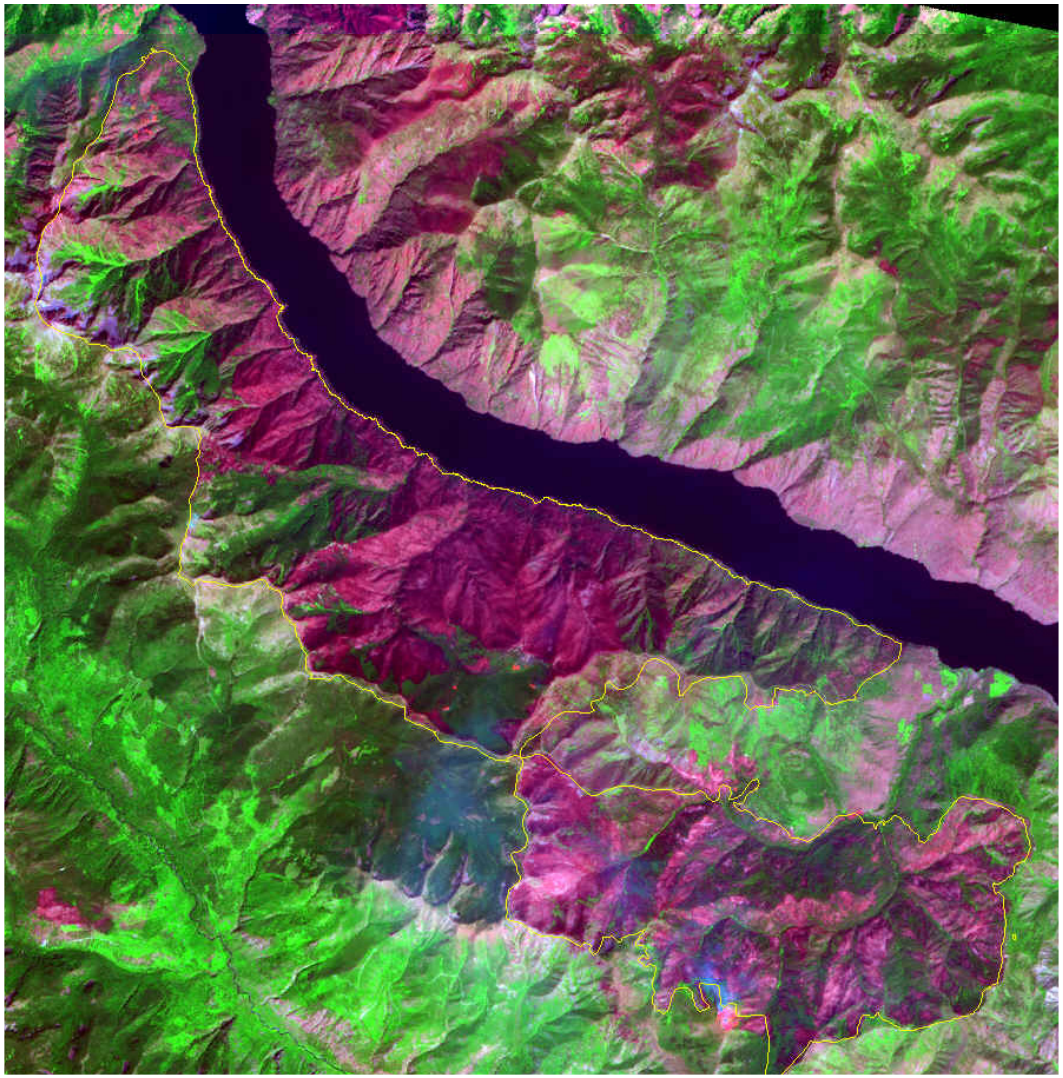
Pot Peak / Sisi Ridge Complex



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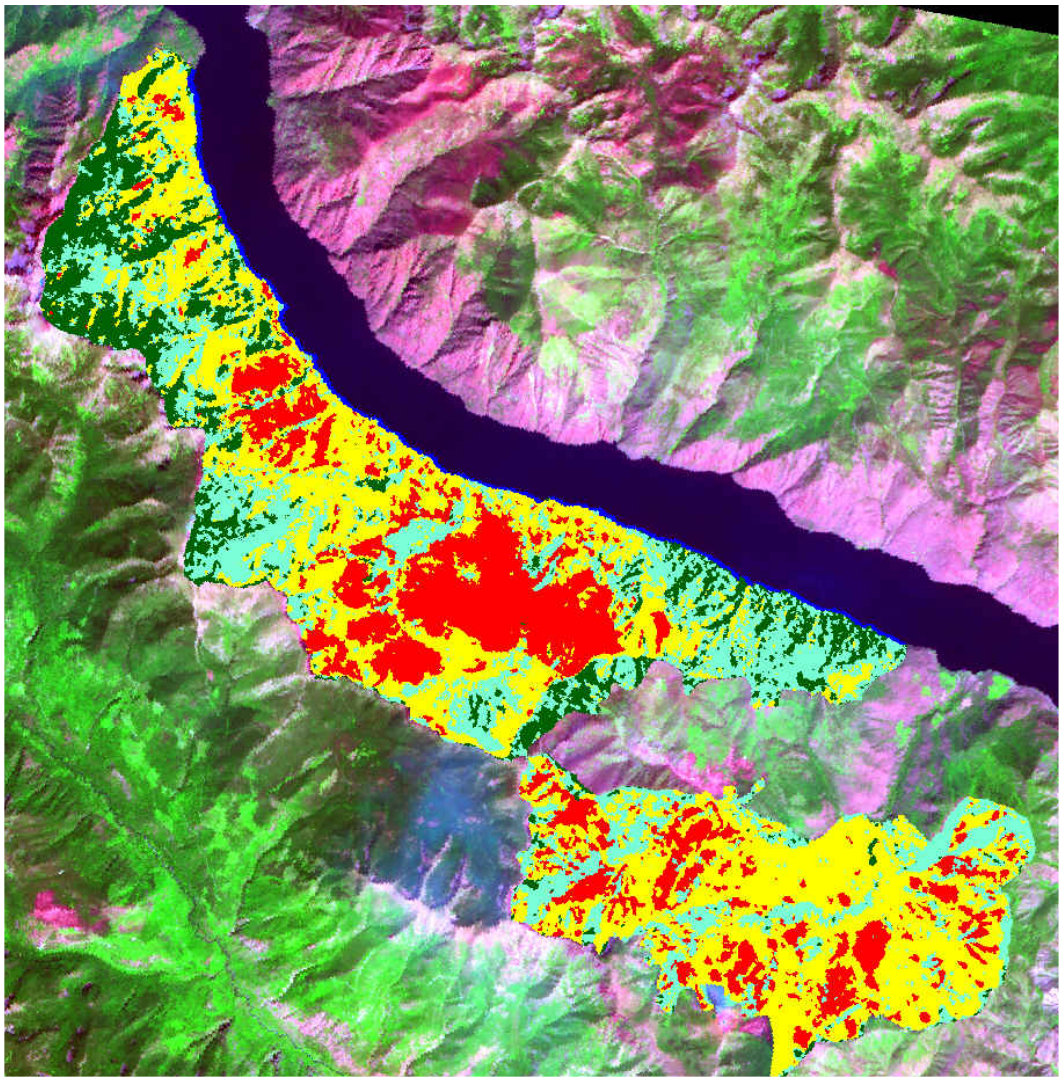
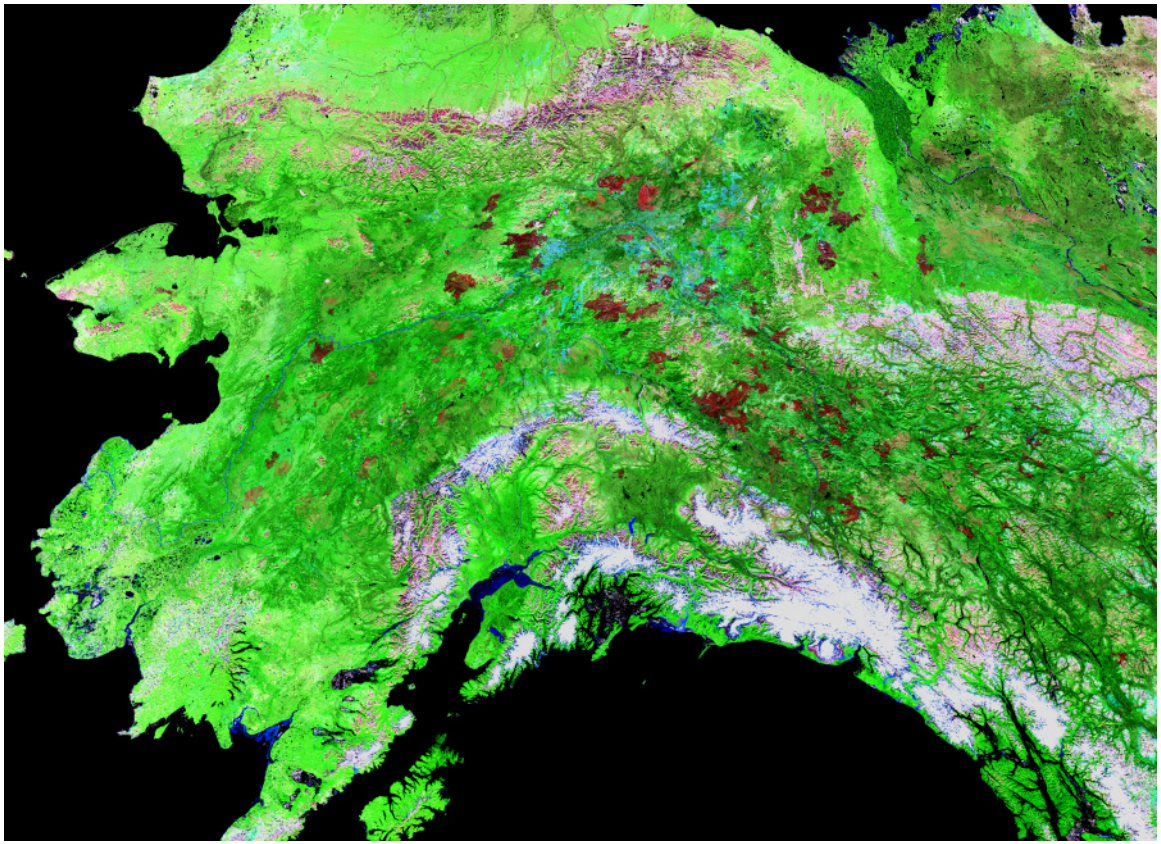
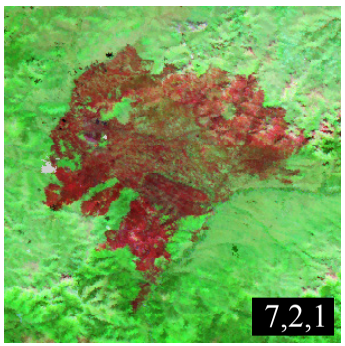
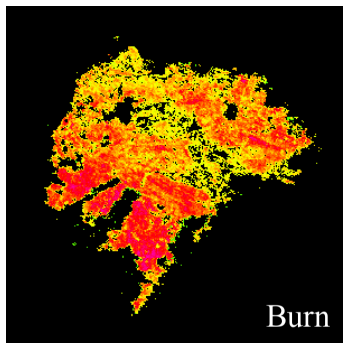
Pot Peak / Sisi Ridge Complex

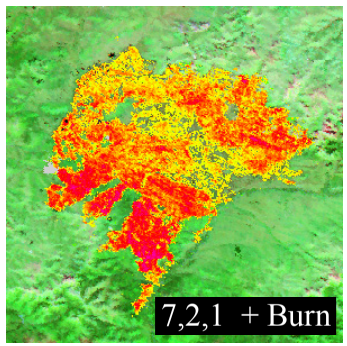


Alaska 2004







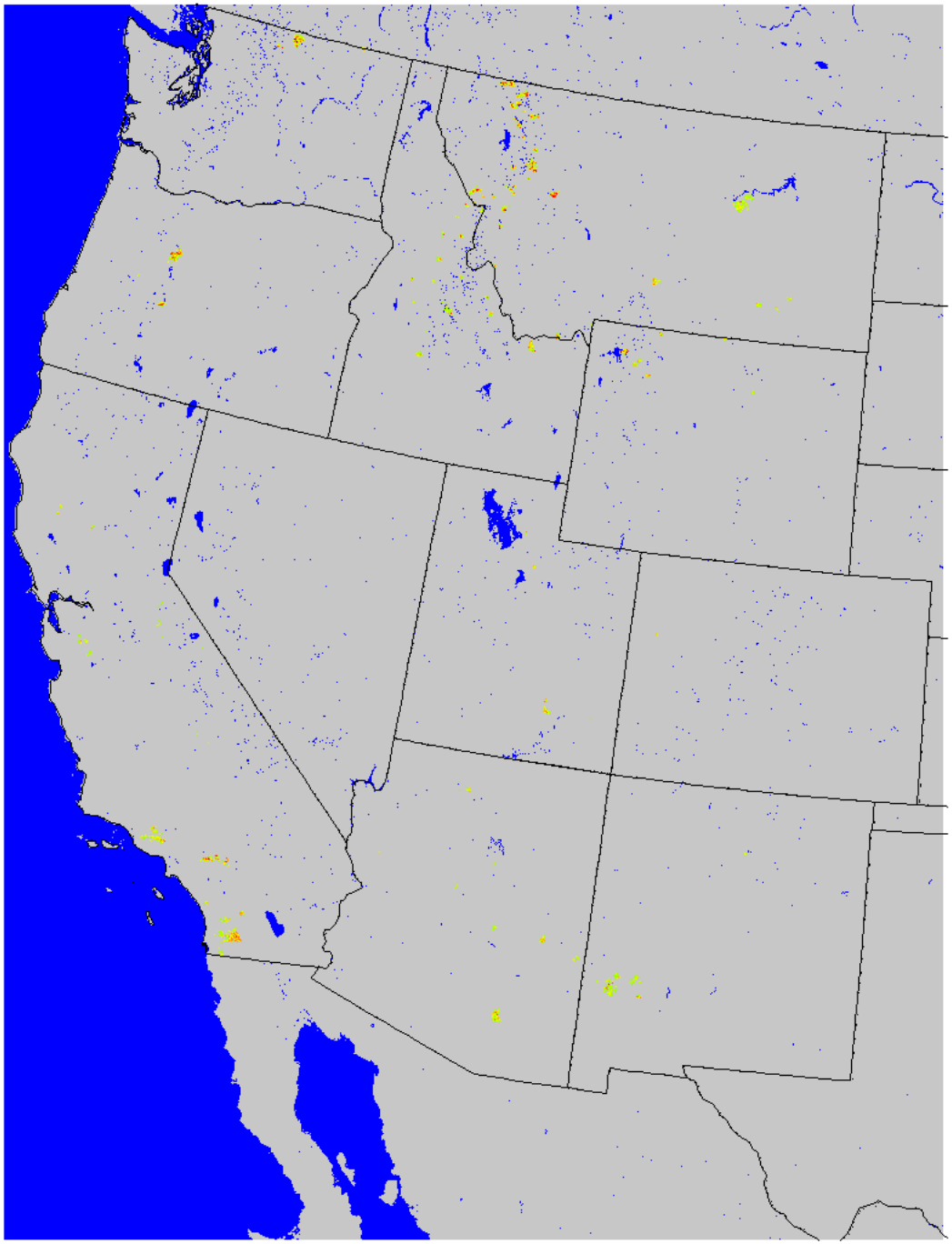


low high

burn intensity

The summer of 2004 was one of the worst fire seasons on record for Alaska. The image to the left is a false color composite using MODIS bands 7,2,1 assigned to R,G,B respectively. The three images below are a full resolution subset of a single burn scar in central alaska and the associated Change Due to Burning product. This product is generated using the Normalized Difference Burn Ratio for two time periods and performing a difference image from them. The MODIS active fire location points are used to "seed" areas to be investigated and the burn scar is "grown" from this initial seed by following natural patterns in the difference image. With the burn identified, a histogram is generated underneath a mask of burned areas and all observations that are greater than 2 standard deviations below the mean are eliminated. This is done to remove outliers and enhance the quality of the product.

2003 Fire Season

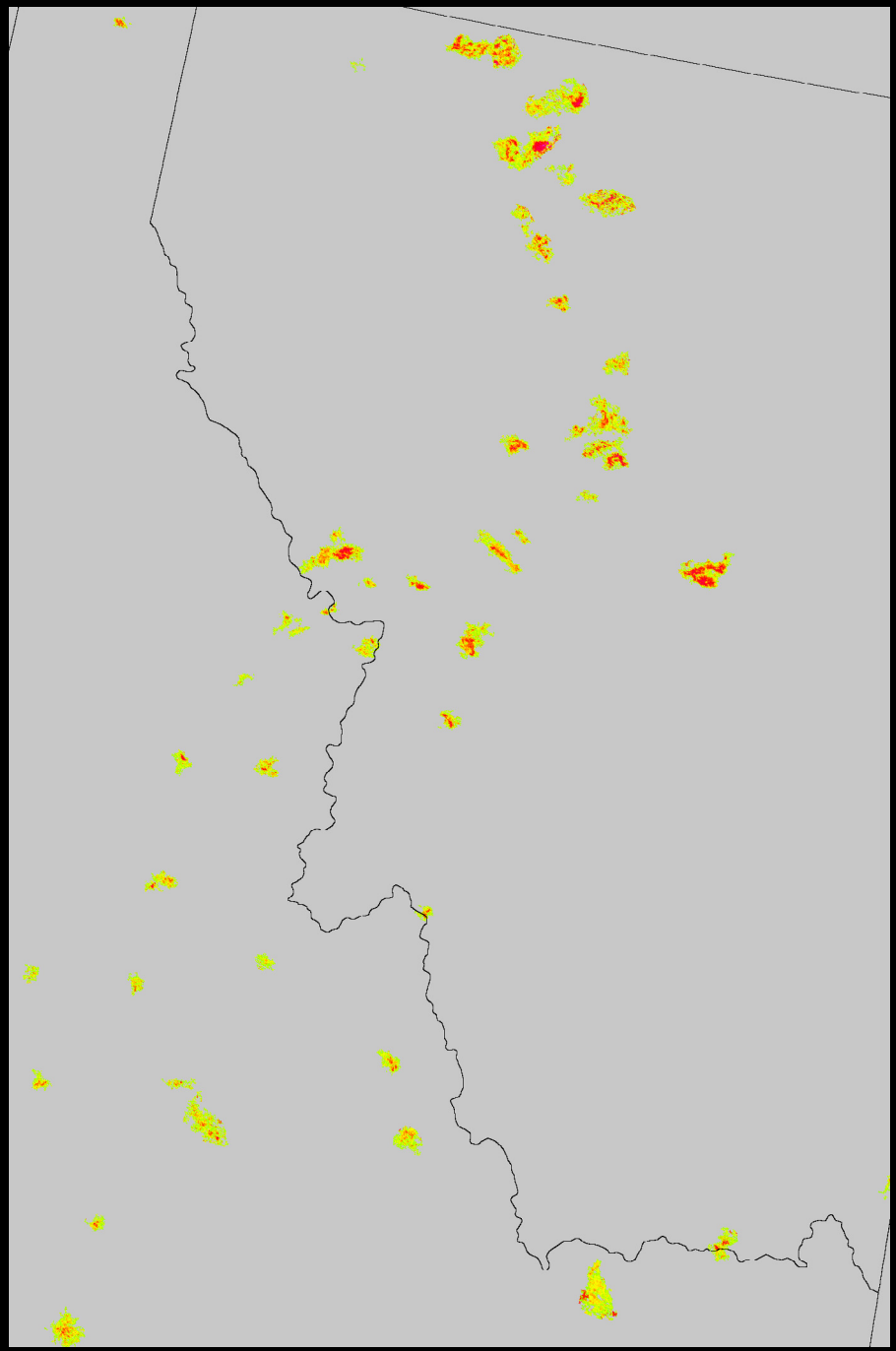


low high

burn intensity

Arizona & New Mexico

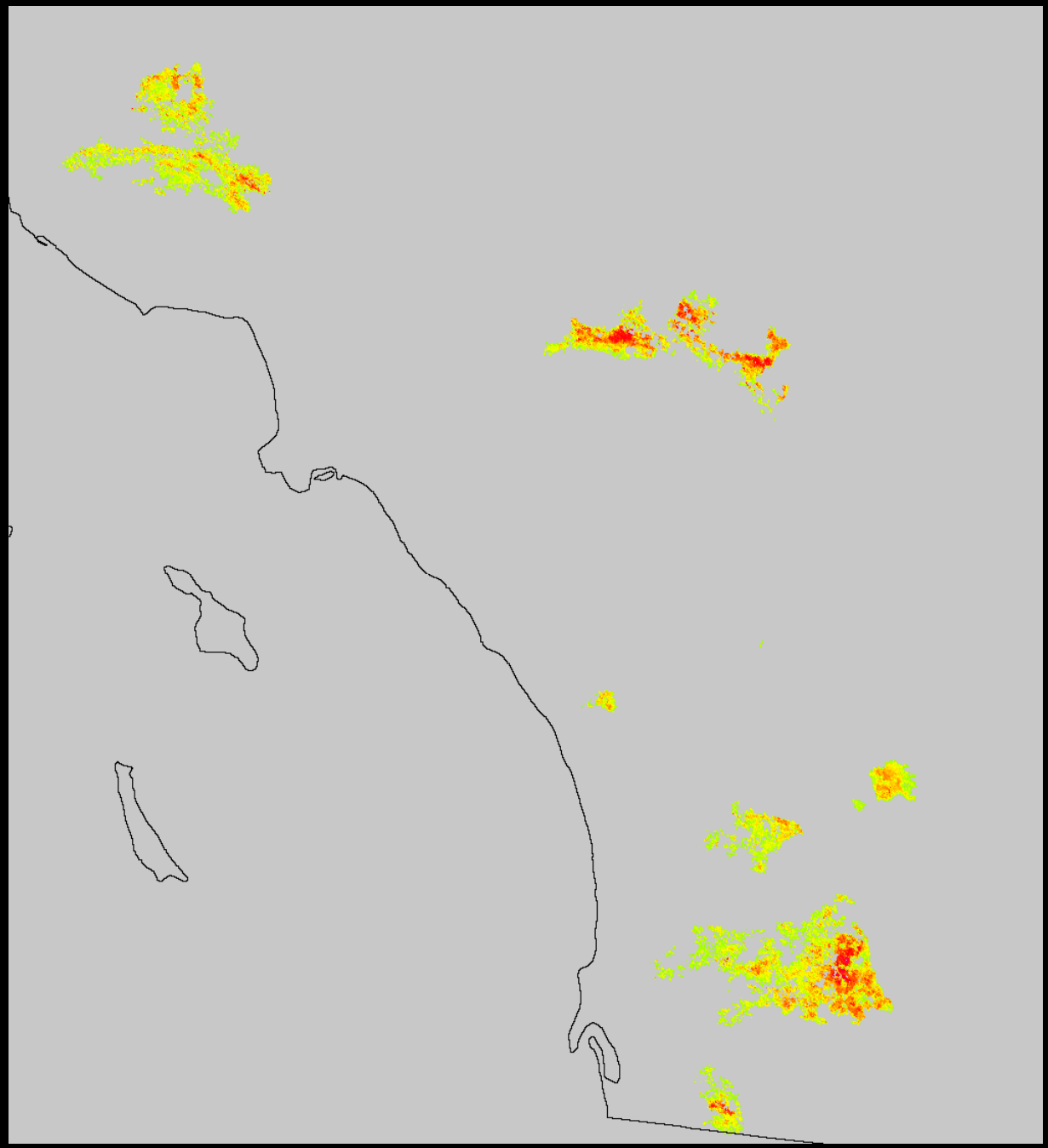
Idaho & Montana



low high

burn intensity

Southern California



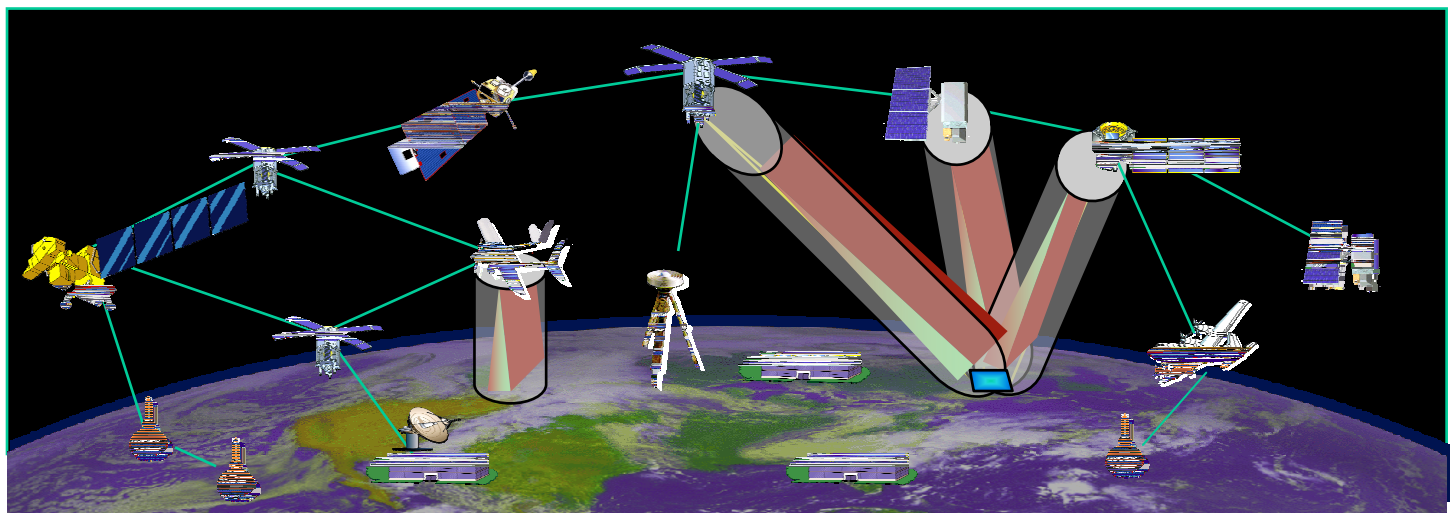
low high

burn intensity

Wildfire SensorWeb

So...what is a sensor web?

A sensor web is a coherent set of distributed "nodes", interconnected by a communications fabric, that collectively behave as a single, dynamically adaptive, observing system.

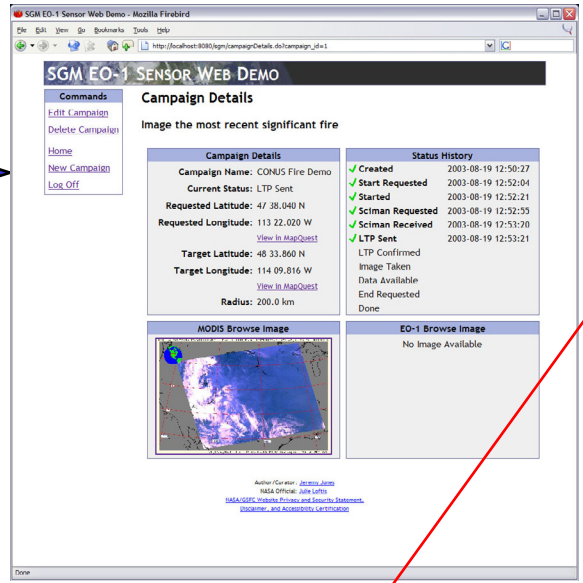


SensorWeb Demonstration Design

- Stratify national priority wildfires using ICS-209 (Situation Report) database at National Interagency Fire Center, Boise.
- Intersect with potential EO-1 acquisitions for the day. Select largest incident.
- Refine targeting using MODIS active fire detections since the incident began.
- Build EO-1 tasking load and relay to spacecraft.
- Acquire image, hold onboard.
- Downlink at USGS Eros Data Center, Sioux Falls. Process to L1.
- Transfer to UMD, College Park, for assembly of SCA strips and conversion to ERDAS format (image processing standard for federal land managers).
- Transfer to USFS Burned Area Emergency Response desk at Remote Sensing Applications Center, Salt Lake City.
- Create burn extent image.
- Transfer to BAER personnel at appropriate fire camp.

SensorWeb Demonstration Scenario
National Priority Wildfires 8-22-03

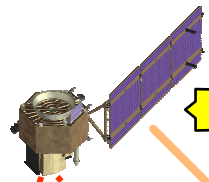
1 Large wild fires tracked by National Interagency Fire Center (NIFC)



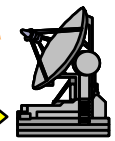
2 SGM correlates selected wildfire (25 Robert) to exact present location using data from Rapid Fire workstation in MODIS Instrument Center which is updated every 5 minutes

3 After ascertaining that the Robert fire is at lat 48.564 long –114.163, EO-1 is tasked to take closer high resolution look

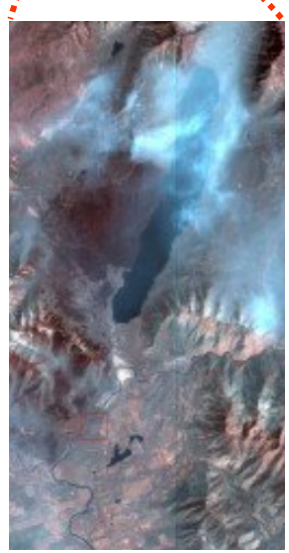
4 SGM causes MOPSS, CMS, CASPER (ground version) to task EO-1 via command load



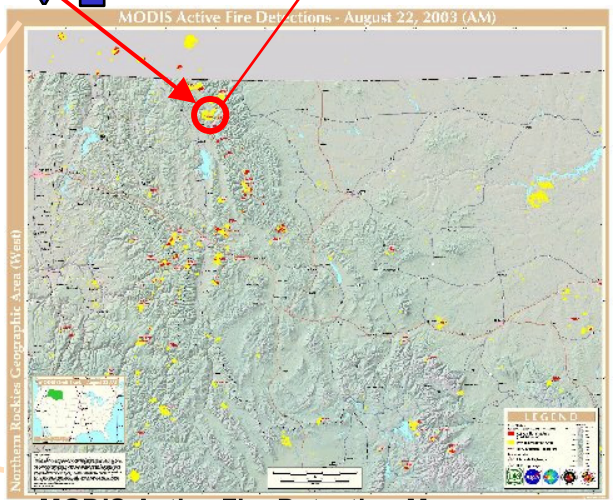
5 and causes EO-1 to downlink the image to EROS Data Center (EDC) at Sioux Falls



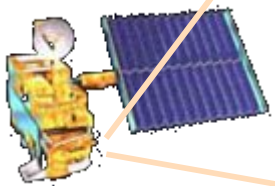
6 EDC performs L0 and L1 processing and FTP's image to Natural Hazards investigators at UMD.



7 UMD team transforms image into ERDAS format and FTP's file to USFS/Salt Lake City where burn extent product is derived. Result is sent to BAER team at Robert Fire.

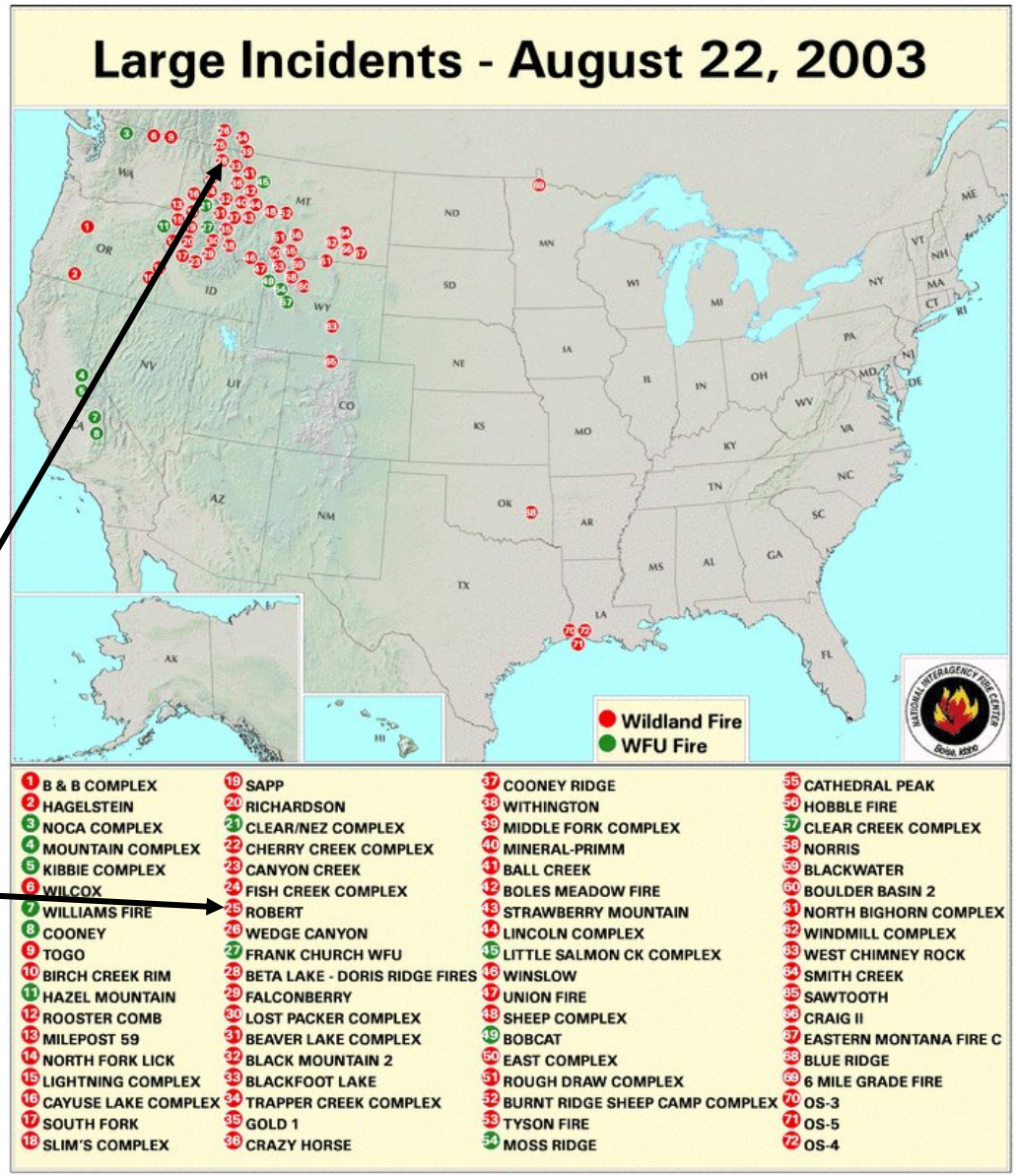


MODIS Active Fire Detection Map



MODIS Instrument on Terra or Aqua

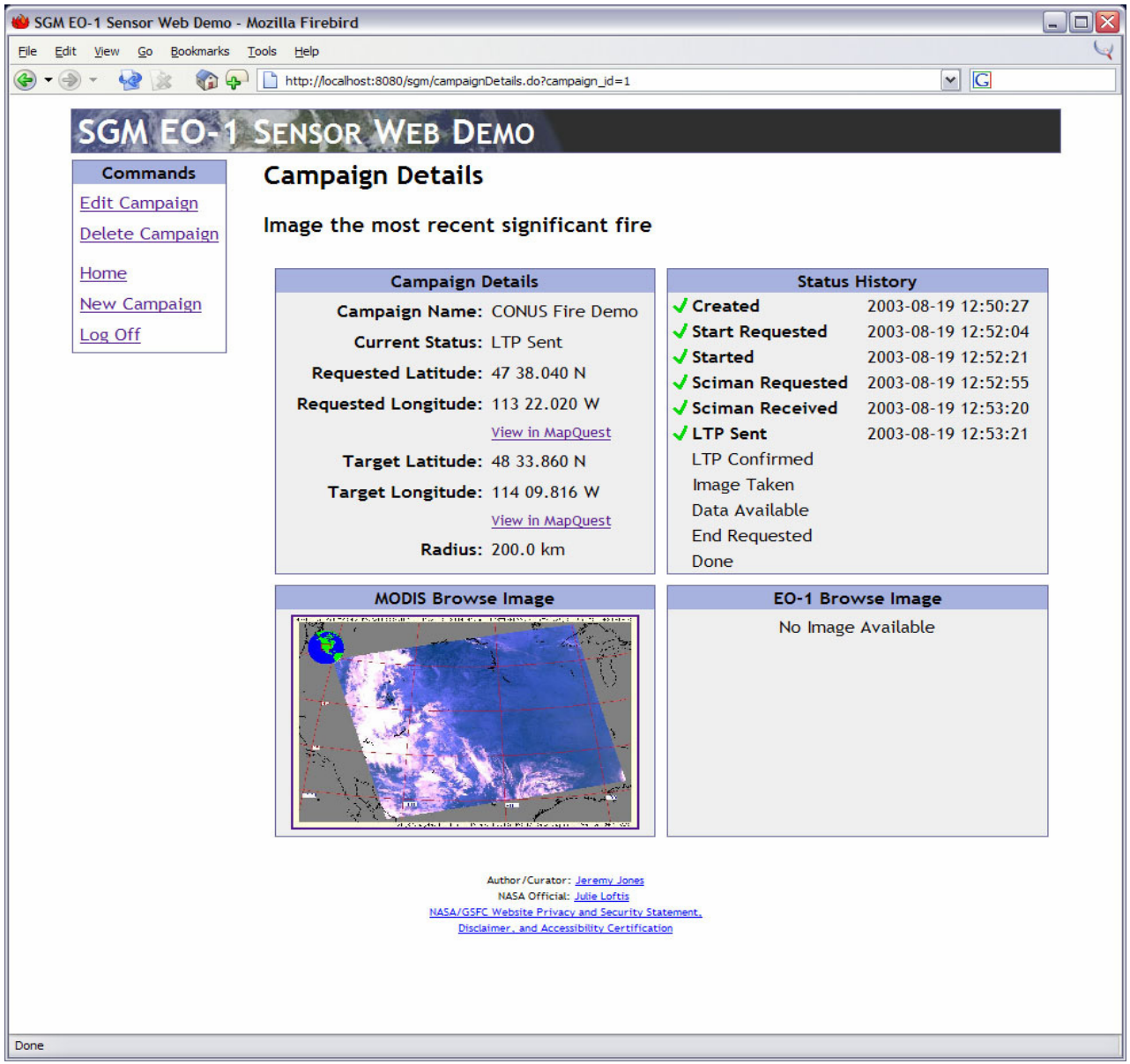
SensorWeb Demonstration
National Interagency Fire Center Display

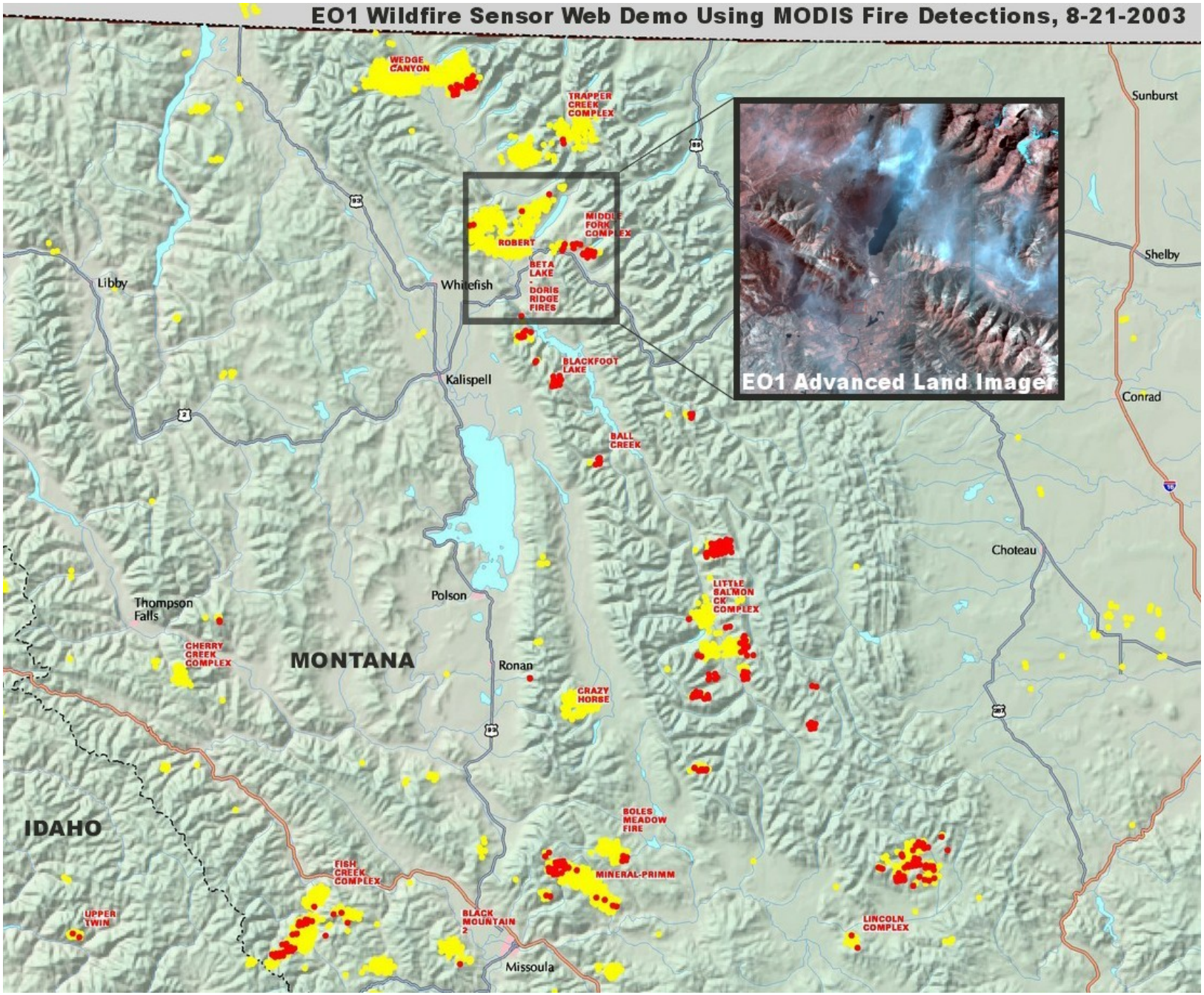


Selected fire for test

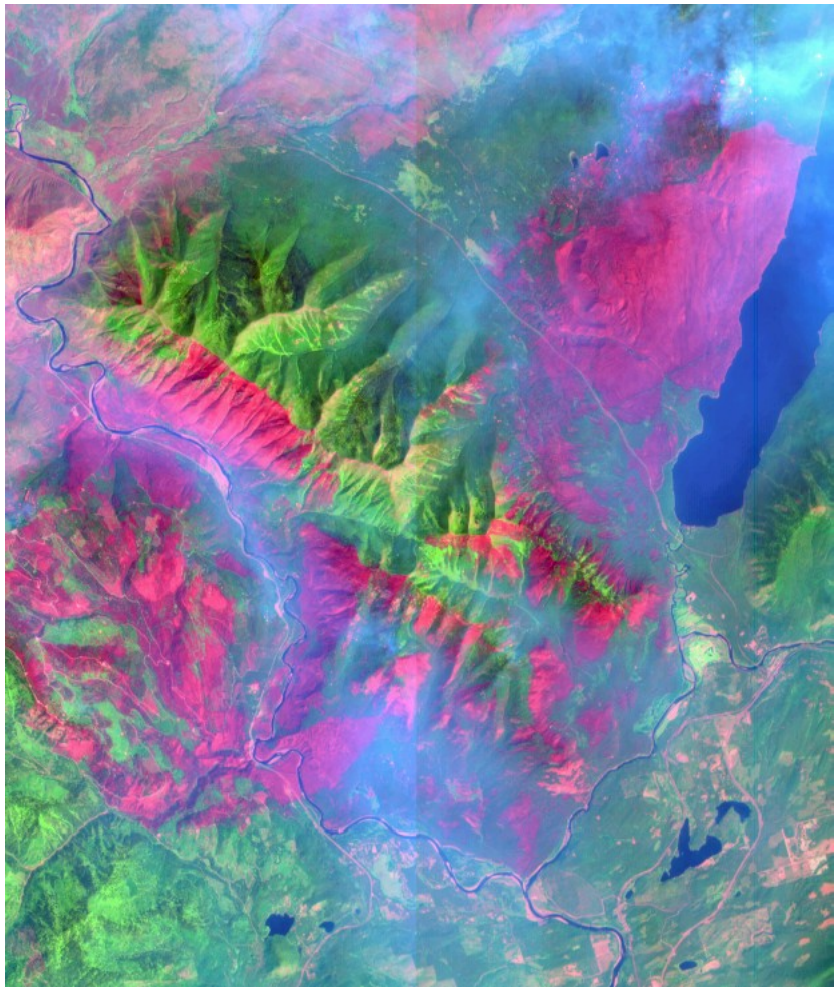
http://www.nifc.gov/information.html

SensorWeb Demonstration
Science Goal Monitor Display




EO1 Wildfire Sensor Web Demo Using MODIS Fire Detections, 8-21-2003
WEDGE CANYON
TRAPPER CREEK COMPLEX
MIDDLE FORK COMPLEX
ROBERT
BETA LAKE - DORIS RIDGE FIRES
BLACKFOOT LAKE
BALL CREEK
LITTLE SALMON CK COMPLEX
CRAZY HORSE
BOLES MEADOW FIRE
MINERAL-PRIMM
FISH CREEK COMPLEX
UPPER TWIN
BLACK MOUNTAIN 2
CHERRY CREEK COMPLEX
LINCOLN COMPLEX
EO1 Advanced Land Imager
Sunburst
Shelby
Conrad
Choteau
Libby
Whitefish
Kalispell
Polson
Ronan
Thompson Falls
Missoula
MONTANA
IDAHO

Burn Extent Image of Robert Fire, Flathead National Forest.
Derived from EO-1 Advanced Land Imager.



Burned area appears red,
healthy vegetation and unburned islands are green,
water is blue.

EO-1 Wildfire Sensor Web Experiment

Detection and Tasking

Use National Inter-agency Fire Center ICS209 database to identify national priority fires.

Locate fire precisely with MODIS Active Fire detections from Terra and Aqua.

Automatically task EO-1 to acquire image data

Geo-rectification

Precisely match image to earth coordinates

Enhance vegetation image to highlight burned areas (red)

Data Processing

Downlink data

Perform Level 0 processing

Perform Level 1 processing

Assessment, Planning and Implementation

Classify burned areas into color coded burn severity, augmented with ground verification

Plan deployment of rehabilitation resources to highest risk areas (red in overlay)

Apply treatments to control things such as erosion, invasive species etc.

Glacier National Park August 21, 2003

Two Burned Area Reflectance Classification (BARC) map overlays are shown on top of Advanced Land Imager (ALI) data taken semi-autonomously by the EO-1 Sensor Web. The EO-1 image request was generated automatically based on fire location triggers detected by MODerate-resolution Imaging Spectro-radiometer (MODIS) Instruments onboard Terra and Aqua satellites. The upper left Overlay is the BARC map for the Robert fire and the lower right. Overlay is the BARC map for the Middle Fork Complex fire. The overlays were created by the Forest Service Burn Area Emergency Response teams to identify areas at high risk and to contract rehabilitation treatments. Satellite data such as this assists in efficient use of resources.

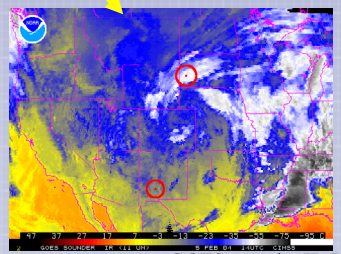
Burn Severity

- Unburned
- Low/Unburned
- Low
- Medium
- High

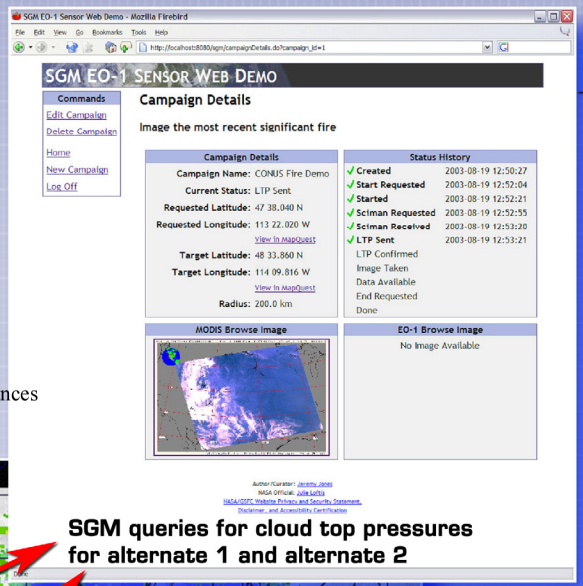
GOES Real-Time Cloud Product Automatically Commands EO-1 to Choose One of Two Scenes

(No manual intervention)

Step1:
Submit 2 competing acquisition targeted for 2-5-04



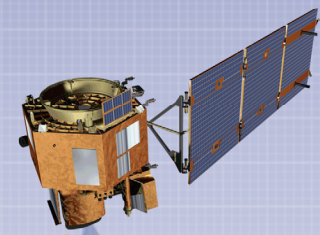
GOES sounder IR Radiances



Step 2:
Automatically query GOES RT cloud data 1-4 hours before overflight

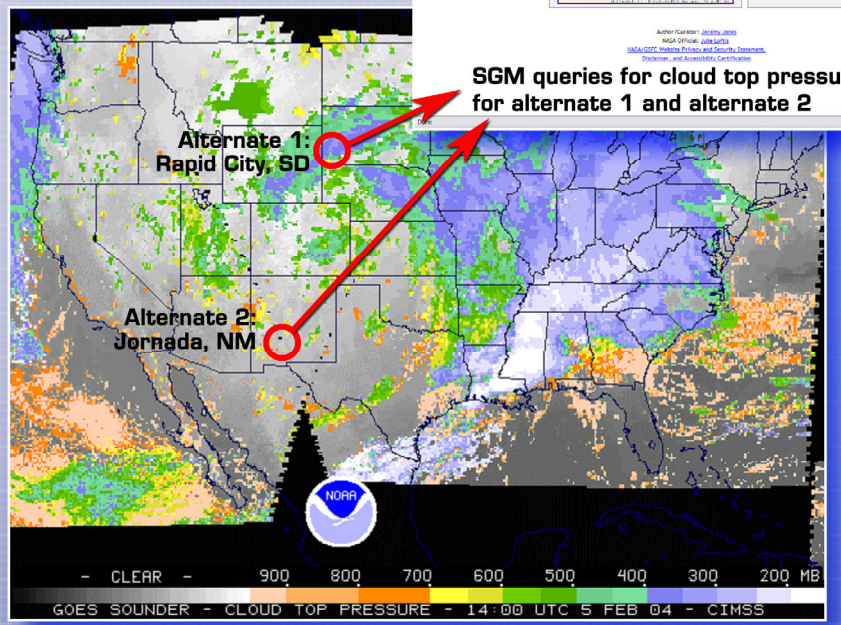
SGM selects least cloudy

Alt 2



RT Command

SGM queries for cloud top pressures for alternate 1 and alternate 2

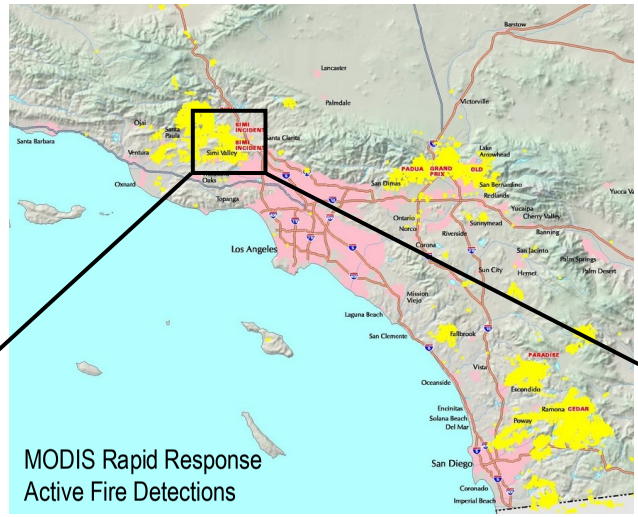


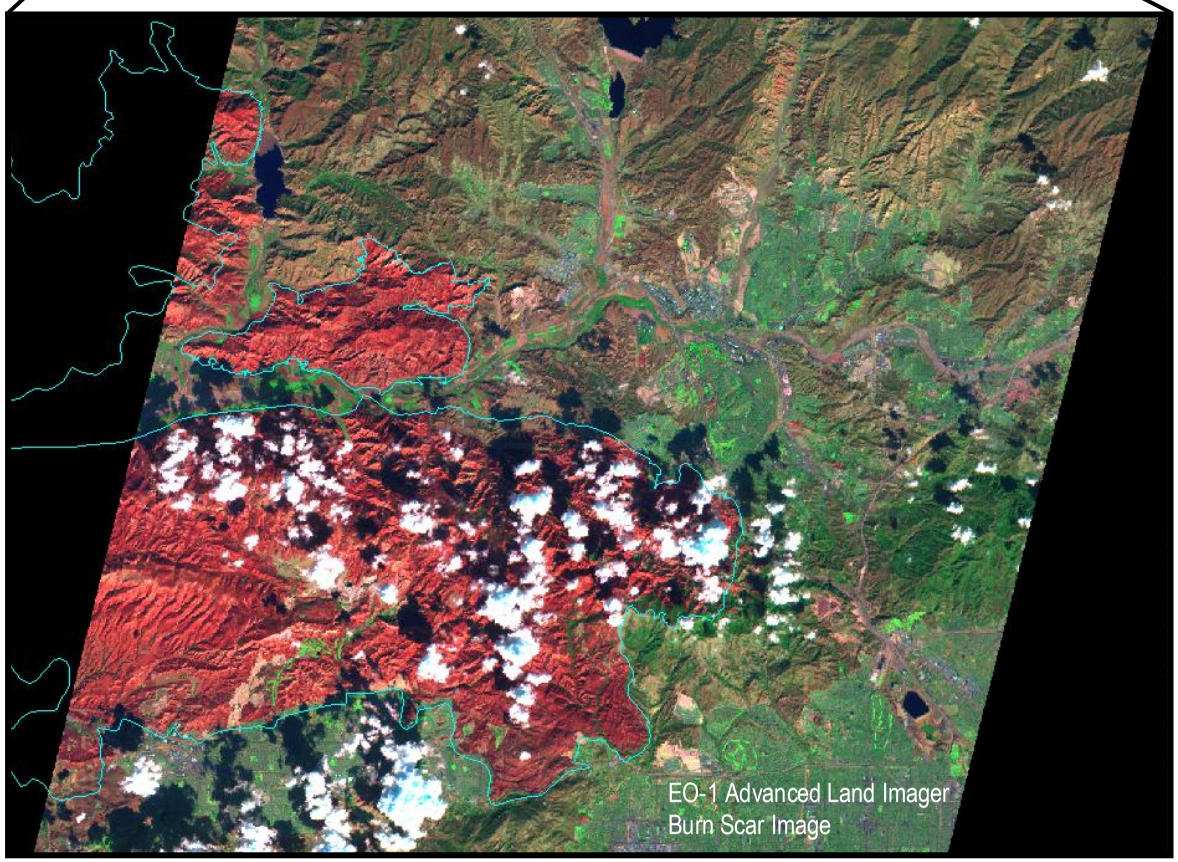
Step 3:
Autonomously command EO-1 to switch to alternate 2 target

EO-1 Missions Ops Center (MOC)

Total Precipitable Water Vapor Derived from the GOES-East and GOES-West Sounders Hourly (10 km pixels) on 2-5-04 at 9:00 am EST

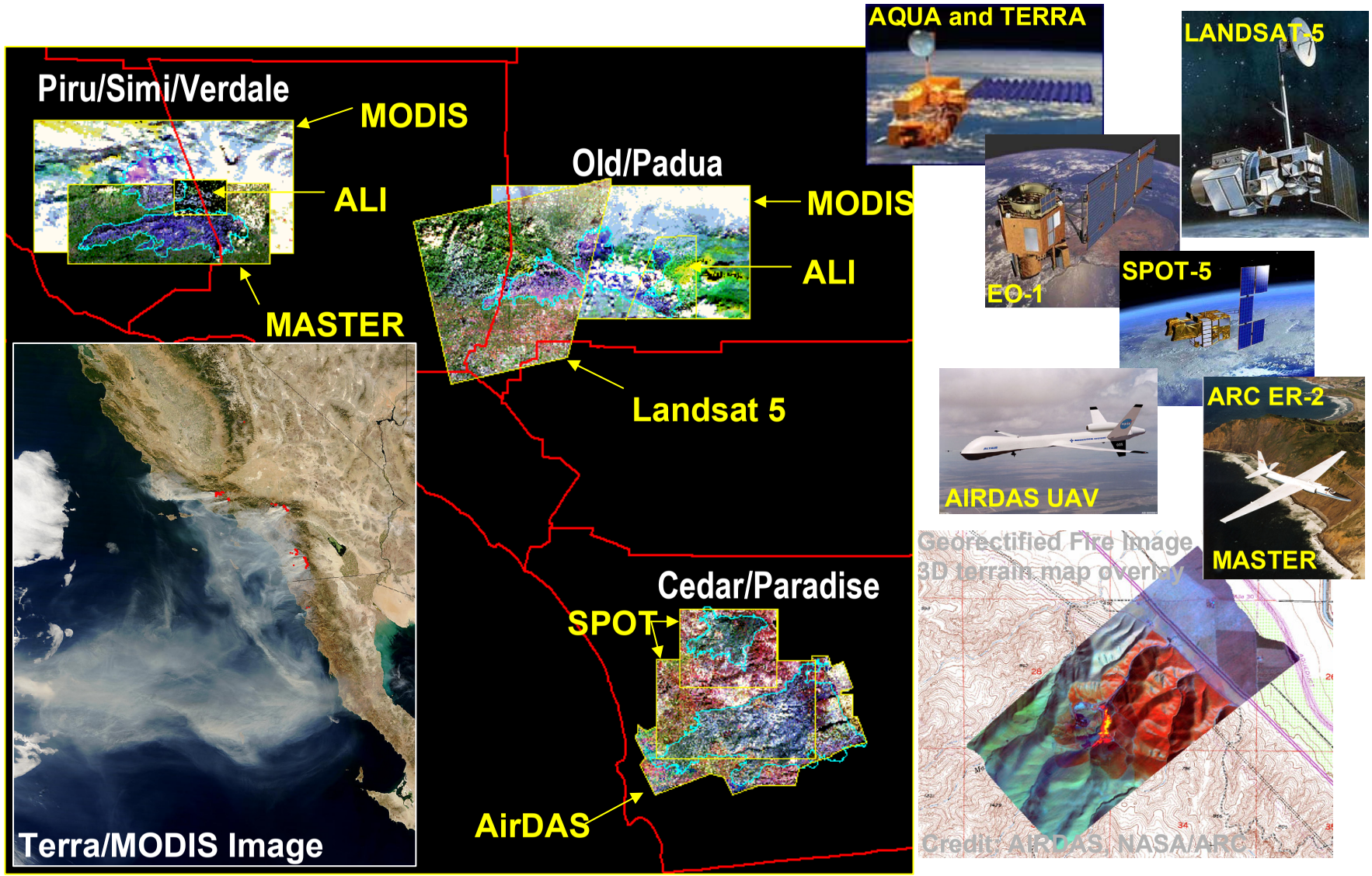
Wildfire SensorWeb





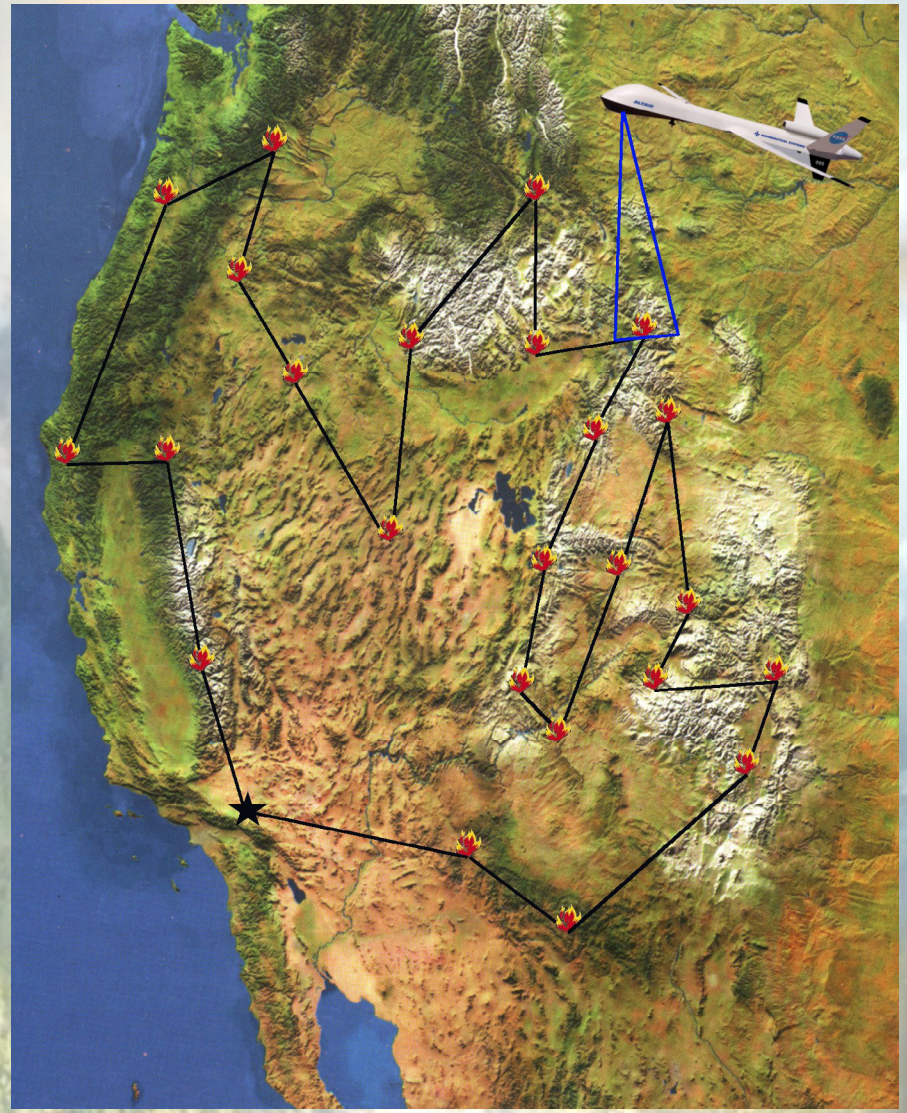
On 11-2-03, the NASA Wildfire SensorWeb was employed to collect data on the burn scars resulting from the Simi Valley, Val Verde and Piru fires in Southern California. MODIS active fire detections for the duration of the event were used to target an acquisition by the ALI and Hyperion instruments onboard EO-1. Such data are employed by the USDA Forest Service for Burned Area Emergency Response mapping. BAER maps are used to target high risk areas for erosion control treatments. In this image, burned areas appear red while the unburned areas appear green. The blue burn perimeter vector is based on ground data.

Integrating Multipoint Observations for Southern California Wildfire Monitoring



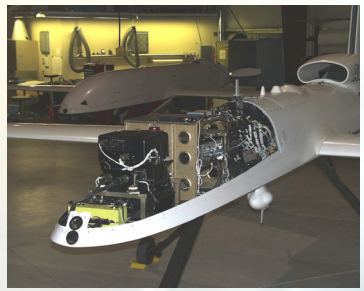
Western States UAV Fire Mission

- Showcase mission for AuRA / IMM, sensor web efforts, and others
- Planned for Late August 2005
- 24-Hour Mission; Launch / Return – Gray Butte, CA
- Over 4000 miles of coverage; border to border and coast to Rocky Mtns.
- Vector to, linger over fires and real-time flight profiling (including descent to 20K, and flying parallel flight-lines)
- Real-time data telemetry to NIFC and USFS-RSAC via CDE
- On-board real-time image geo-rectification and processing



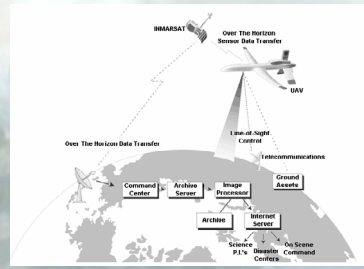
UAV Western States Fire Mission

Demonstrate Capabilities For UAV Tactical Fire Imaging Mission

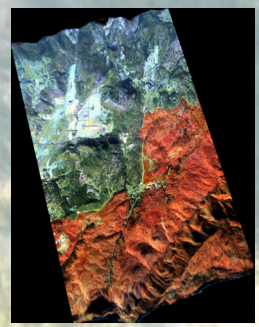


– **Sensor Capabilities**
  - High altitude capability
  - Long-duration operability
  - Calibrated fire information enabling

– **Real-Time OTH Data Telemetry**
  - On-board processing
  - Real-time telemetry to USFS



– **UAV HALE Operations**
  - 40K feet with transitioning to 20K.
  - 24 hour mission
  - Coverage over entire Western US



UAV Mission Operations

ALTAIR UAV
System Specifications

Dimensions	Wing Span 84 ft.; Length 36.2 ft.; Height 11.8 ft.
Weights	Max Fuel Wt. 3500 lb; Payload Wt. 750 lb.; Max GTOW 7700 lbs.
Performance	Max Altitude: 55,000 ft.; Endurance: 32 Hours (with 700 lb payload); Cruise/Loiter Speed 144 KIAS; Range: 4500 nm
Payload Specs	Size: 80"L x 35"H x 40"W, (Adaptable); Max Wt. 750 lbs., Payload
Navigation	Three integrated Emus and three Differential GPS (optional P-code)
Avionics	C-Band LOS Range: 100 nm; 500 Kbs Ku-band OTH Operations; autonomous flight (no data link)

GA-ASI ALTAIR UAV Platform

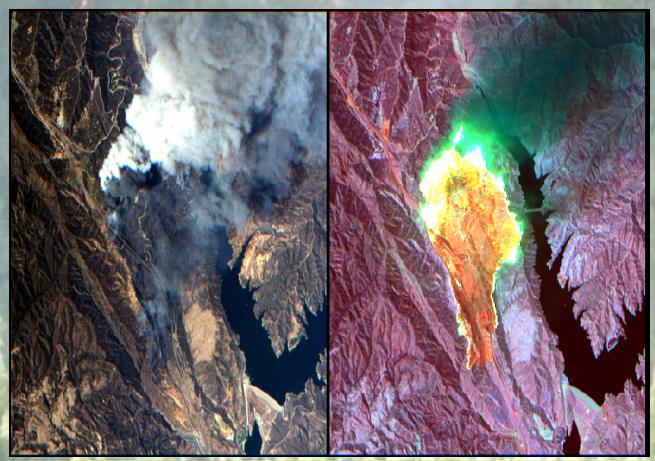
Ground Control Station

GA-ASI Mariner UAV platform with accompanying "belly" pod.

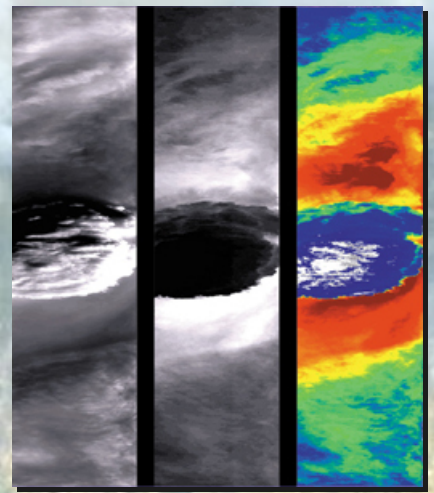
Three NASA Airborne Science Instruments Are Being Converted Into A Single Modular System for UAV Operations

- Atmospheric Mapping Sensor (formerly MAMS)
- Wild Fire Sensor (formerly TMS)
- Ocean Color Imager (formerly AOCI-CZCS)
- 3 Systems Share New Scanning Optics and Data Modules

NASA Altair UAV


Wild Fire Research (TMS)

Ocean Color / Coral Reef Research (AOCI)


Hurricane and Atmospheric Studies (MAMS)

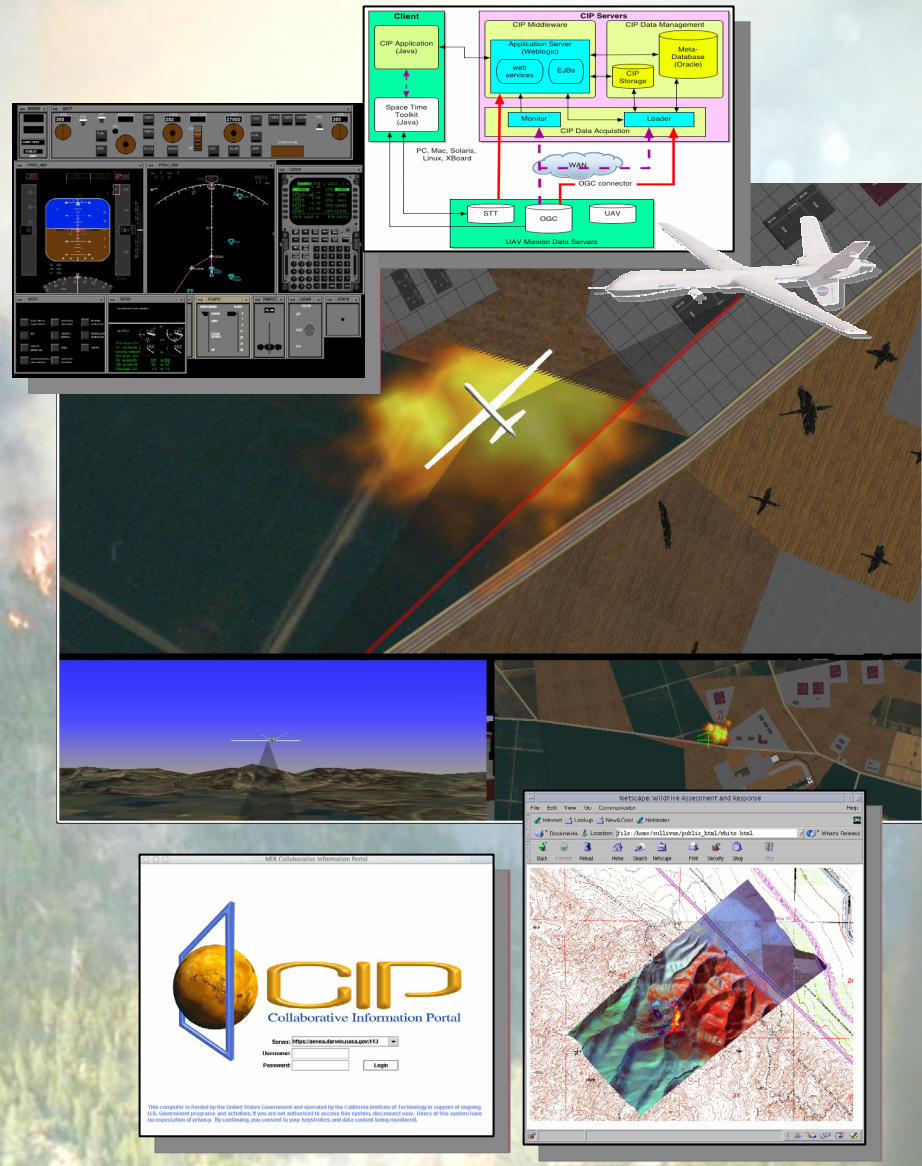
NASA
Airborne Sensor Facility
Ames Research Center

VEHICLE SYSTEMS
Where Innovation Soars

AERONAUTICS research

Intelligent Mission Management
"An Aeronautics and Earth Science Partnership"

To develop air vehicle and associated ground element technology to enhance mission success, enable new missions, and increase science return while reducing operator workload.



Intelligent/Autonomous Architectures

Increase levels of vehicle and mission autonomy by developing and demonstrating real-time flight planning, long endurance unaided autonomous navigation, and payload-directed flight.

Collaborative and Coordinated Systems

Provide mission/science team and end users a seamless interface to the payload systems, and to any external data sets, personnel, or sources of information necessary for the accomplishment of that mission.

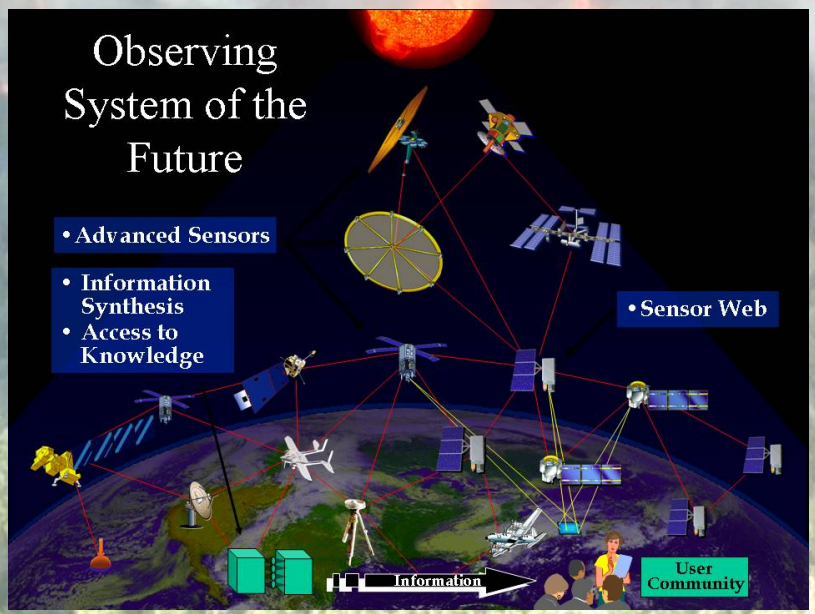
Western States Fire Mission

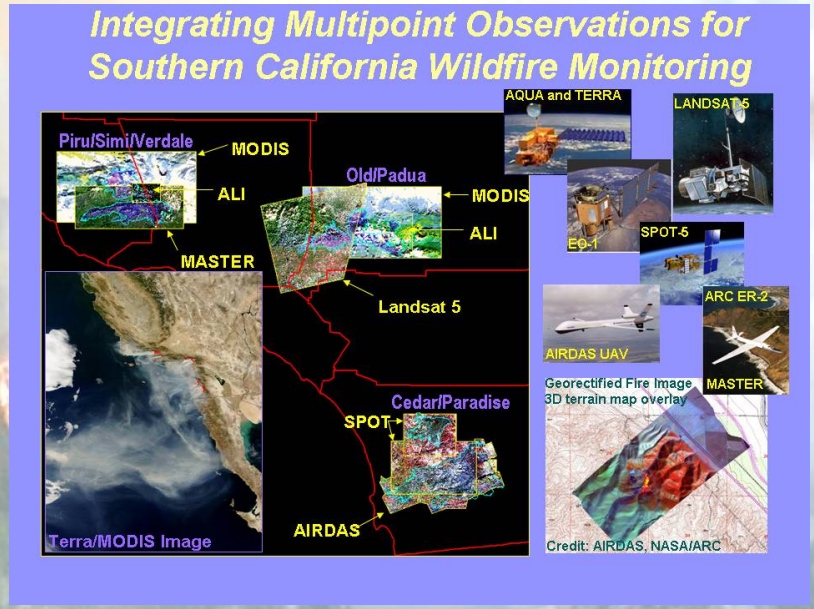
Synergistic Collaborations

Sensor Web Demonstration

Networked set of instruments in which information from one sensor is *automatically* used to direct additional assets.

A range of assets are required to rapidly provide necessary fire information.





GSFC / UMd collaborate with ARC / DFRC to demonstrate capability of a UAV being tasked, based upon satellite observations.

Paves the way for the next generation orbital and sub-orbital sensor and platform systems

WRAP

Wildfire Research and Applications Partnership

Terra & Aqua MODIS imaging fires

UAV Platform Fire Imaging

COMSAT Telemetry & Platform C&C

GOES Weather Data

Asset Tracking

Intelligent Mission Management / CDE

Telemetry / C&C Downlink

Aircraft Operations

Payload Operations

Define aircraft ops

Remote Observer NASA HQ

NIFC NIC

USFS RSAC

IC Fire Camps

Wide Area Network

Direct Broadcast Receiving Station USFS RSAC

Active Fire Maps
http://activefiremaps.fs.fed.us
Three times / day

Tactical Fire Information DSS

WRAP Project Webpage
http://geo.arc.nasa.gov/sge/WRAP

Tactical Fire Products

GeoTiff & Perimeter File

Outreach

Positive Media Coverage for All Partners

CNN

9 EYEWITNESS NEWS

Bloomberg TELEVISION

Discovery CHANNEL

AP Associated Press

FLORIDA TODAY

The Guardian

BBC NEWS

GOOD MORNING america

Forestry Source

fox5 morningnews

The New York Times

UNITED PRESS INTERNATIONAL

MSNBC

San Jose Mercury News

Beef Today

BusinessWeek

abc 7 NEWS

REUTERS

THE SUN

13 WJZ

Federal Computer Week

Communications Daily

Satellite Week

abc RADIO NETWORKS

THE TIMES

Every Second Counts

Plus 40 stations which ran the NASA-TV video file.

Outreach to Community

- IGARSS
- ASPRS
- AGU
- RS2004
- AMS
- Science Teachers

The End